

## CONTRACT FOR CONSTRUCTION

**THIS CONTRACT FOR CONSTRUCTION (“Contract”)** is made and entered into as of the date stated on the City’s signature page below (the **“Effective Date”**) by and between the **CITY AND COUNTY OF DENVER**, a municipal corporation of the State of Colorado acting on behalf of its Department of Aviation (the **“City”**), and **FLATIRON CONSTRUCTORS, INC.**, a Delaware corporation authorized to do business in the State of Colorado (**“Contractor”**) (collectively the **“Parties”**).

### WITNESSETH

**WHEREAS**, the City, for at least three (3) consecutive days, advertised that proposals would be received for furnishing all labor, tools, supplies, equipment, materials and everything necessary and required for the construction and installation of the work under **Invitation for Bid (Construction) No. 202366450, Taxiway DS East and Deicing Pad** (the **“Project”**) at Denver International Airport (**“DEN”**); and

**WHEREAS**, bids in response to said advertisement have been received by the Chief Executive Officer of Denver International Airport (the **“CEO”**), who has recommended that a contract for the work be made and entered into with Contractor, which was the lowest, responsive, qualified bidder; and

**WHEREAS**, Contractor is qualified, willing, and able to perform the Project in accordance with its proposal and the Contract Documents defined below;

**NOW, THEREFORE**, for and in consideration of the compensation to be paid by the City to Contractor and the other terms and conditions of this Contract, the Parties agree as follows:

#### 1. CONTRACT DOCUMENTS:

It is agreed by the Parties that the instruments, drawings, and documents described below and whether attached to and bound with this Contract or not (the **“Contract Documents”**), are incorporated into the Contract by this reference, and are as fully a part of this Contract as if they were set out here verbatim and in full:

- Contract
- Notice to Proceed
- Form of Final Receipt
- Building Information Modeling (**“BIM”**) if applicable
- Change Directives
- Change Orders
- Exhibit A Federal Appendices
- Exhibit B Equal Employment Opportunity Provisions
- Exhibit C Insurance Requirements
- Exhibit D Prevailing Wage Schedules
- Exhibit E Special Conditions

- Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the “Yellow Book”) (“General Conditions”) (Table of Contents attached as Exhibit F)
- Exhibit G Performance Bond
- Exhibit H Payment Bond
- Exhibit I Technical Specifications
- Exhibit J Contract Drawings
- Exhibit K Invitation for Bids and Contractor’s Response to Invitation for Bids

In the event of an irreconcilable conflict between a provision of Section 1 through 31 of this Contract document and any other provisions of the Contract Documents such that it is impossible to give effect to both, the order of precedence to determine which document shall control to resolve such conflict is as follows, in descending order:

1. Exhibit A Federal Appendices
2. Contract
3. Change Directives
4. Change Orders
5. Exhibit B Equal Employment Opportunity Provisions
6. Exhibit E Special Conditions
7. Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the “Yellow Book” or “General Conditions”) (Table of Contents attached as Exhibit F)
8. Exhibit C Insurance Requirements
9. Exhibit D Prevailing Wage Schedules
10. Exhibit I Technical Specifications
11. Exhibit J Contract Drawings
12. Exhibit K Invitation for Bids and Contractor’s Response to Invitation for Bids
13. Exhibit G Performance Bond
14. Exhibit H Payment Bond
15. Notice to Proceed
16. Form of Final Receipt
17. Building Information Modeling (“BIM”) if applicable

The remaining order of precedence is established in General Conditions Title 4.

## 2. SCOPE OF WORK:

Contractor shall furnish all labor and tools, supplies, equipment, superintendence, materials, and everything necessary for and required to do, perform, and complete all of the work described, drawn, set forth, shown, and included in the Contract Documents (the “Work”).

## 3. TERM OF CONTRACT:

The Senior Vice President of Aviation – Airport Infrastructure Management (the “SVP-AIM”) will issue a written notice to proceed to Contractor (the “Notice to Proceed”), and

Contractor shall begin performing the Work required under this Contract within ten (10) days of such Notice to Proceed (the “**Commencement Date**”). Contractor shall fully complete the Work in its entirety within **Four Hundred Eleven (411)** consecutive calendar days from the date of the Notice to Proceed (“**Contract Time**”). Contractor is not authorized to commence work prior to its receipt of the Notice to Proceed.

**4. TERMS OF PAYMENT:**

The City agrees to pay Contractor for the performance and completion of all of the Work as required by the Contract Documents, and Contractor agrees to accept as its full and only compensation therefor, a total amount of **Sixty Million Four Hundred Sixty-One Thousand Seven Hundred and Seventy Dollars and Five Cents (\$60,461,770.05)** (the “**Maximum Contract Amount**”). In no event will the City’s liability exceed the Maximum Contract Amount, as adjusted by duly authorized Change Orders in accordance with this Contract. The Parties specifically agree that any performance by Contractor hereunder shall not subject the City to any cost, charge, or fee not specified above.

**5. VERIFIED STATEMENT OF CLAIMS:**

Colorado Revised Statutes § 38-26-107 (“**C.R.S.**”) requires that, in the event any person or company files a verified statement of amounts due and unpaid in connection with a claim for labor and materials supplied on this project, the City shall withhold from payments to Contractor sufficient funds to insure the payment of any such claims. Should the City be made a party to any lawsuit to enforce such unpaid claims or any lawsuit arising out of or relating to such withheld funds, Contractor agrees to pay to the City its costs and a reasonable attorney’s fee incurred in any such lawsuit. Because the City Attorney Staff does not bill the City for legal services on an hourly basis, Contractor agrees a reasonable fee shall be computed at the rate of two hundred dollars and no cents (\$200.00) per hour of City Attorney time.

**6. DISPUTES:**

All disputes arising under or related to this Contract shall be resolved by administrative hearing under the procedures described in **Exhibit F**, as modified by **Exhibit E**, if any, and the Denver Revised Municipal Code § 5-17 (“**D.R.M.C.**”) and all related rules and procedures, including but not limited to DEN Rule 250. The determination resulting from said administrative hearing shall be final, subject only to Contractor’s right to appeal the determination under Colorado Rule of Civil Procedure, Rule 106.

**7. DEFENSE AND INDEMNIFICATION:**

**A.** To the fullest extent permitted by law, Contractor hereby agrees to defend, indemnify, reimburse and hold harmless City, its appointed and elected officials, agents and employees for, from and against all liabilities, claims, judgments, suits or demands for damages to persons or property arising out of, resulting from, or related to the work performed under this Contract that are due to the negligence or fault of the Contractor or the Contractor’s agents, representatives, subcontractors, or suppliers (“**Claims**”). This indemnity shall be interpreted in the broadest possible manner consistent with the applicable law to indemnify the City.

**B.** Contractor's duty to defend and indemnify City shall arise at the time written notice of the Claim is first provided to City regardless of whether suit has been filed and even if Contractor is not named as a Defendant.

**C.** Contractor will defend any and all Claims which may be brought or threatened against City and will pay on behalf of City any expenses incurred by reason of such Claims including, but not limited to, court costs and attorney fees incurred in defending and investigating such Claims or seeking to enforce this indemnity obligation, including but not limited to time expended by the City Attorney Staff, whose costs shall be computed at the rate specified in Section 5 . Such payments on behalf of City shall be in addition to any other legal remedies available to City and shall not be considered City's exclusive remedy.

**D.** Insurance coverage requirements specified in this Contract shall in no way lessen or limit the liability of the Contractor under the terms of this indemnification obligation. The Contractor shall obtain, at its own expense, any additional insurance that it deems necessary for the City's protection.

**E.** This defense and indemnification obligation shall survive the expiration or termination of this Contract.

**8. WAIVER OF C.R.S. § 13-20-801, et seq.:**

Notwithstanding any other provision of this Contract, Contractor specifically waives all of the provisions of C.R.S. §§ 13-20-801 *et seq.* as they may relate to Contractor's performance.

**9. LIQUIDATED DAMAGES:**

If Contractor fails to achieve Substantial Completion of the Work within the Contract Time or fails to substantially complete the Work described in the Scope of Work within the time set forth in the Special Conditions, the City will suffer substantial damages, which damages would be difficult to accurately determine. The Parties hereto have considered the possible elements of damages and have agreed that the amount of liquidated damages for Contractor's failure to substantially complete the work within the Contract Time or to substantially complete the work described in Milestone Areas within the time set forth in the Special Conditions shall be as provided in the Special Conditions. If Contractor shall fail to pay such liquidated damages promptly upon demand therefor, the Surety on its Performance Bond and Payment Bond shall pay such damages. Also, the City may withhold all, or any part of, such liquidated damages from any payment due to Contractor. Additional provisions relating to liquidated damages are set forth in the Construction Contract General Conditions and Special Conditions.

**10. INSURANCE REQUIREMENTS:**

**A.** Contractor shall obtain and keep in force all of the minimum insurance coverage forms and amounts set forth in **Exhibit C** ("**Insurance Requirements**") during the entire Term of this Agreement, including any extensions of the Agreement or other extended period stipulations stated in **Exhibit C**. All certificates of insurance must be received and accepted by the City before any airport access or work commences.

**B.** Contractor shall ensure and document that all subcontractors performing services or providing goods hereunder procure and maintain insurance coverage that is appropriate to the primary business risks for their respective scopes of performance. At minimum, such insurance must conform to all applicable requirements of DEN Rules and Regulations Part 230 and all other applicable laws and regulations.

**C.** The City in no way warrants or represents the minimum limits contained herein are sufficient to protect Contractor from liabilities arising out of the performance of the terms and conditions of this Contract by Contractor, its agents, representatives, employees, or subcontractors. Contractor shall assess its own risks and maintain higher limits and/or broader coverage as it deems appropriate and/or prudent. Contractor is not relieved of any liability or other obligations assumed or undertaken pursuant to this Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration, or types.

**D.** In no event shall the City be liable for any of the following: (i) business interruption or other consequential damages sustained by Contractor; (ii) damage, theft, or destruction of Contractor's inventory, or property of any kind; or (iii) damage, theft, or destruction of an automobile, whether or not insured.

**E.** The Parties understand and agree that the City, its elected and appointed officials, employees, agents and volunteers are relying on, and do not waive or intend to waive by any provisions of this Contract, the monetary limitations and any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, C.R.S. §§ 24-10-101, *et seq.*, or otherwise available to the City, its elected and appointed officials, employees, agents and volunteers.

**11. CONTRACT BINDING:**

It is agreed that this Contract shall be binding on and inure to the benefit of the Parties hereto, their heirs, executors, administrators, assigns, and successors.

**12. SEVERABILITY:**

If any part, portion, or provision of this Contract shall be found or declared null, void, or unenforceable for any reason whatsoever by any court of competent jurisdiction or any governmental agency having authority thereover, only such part, portion, or provision shall be affected thereby and all other parts, portions, and provisions of this Contract shall remain in full force and effect.

**13. ASSIGNMENT:**

Contractor shall not assign, pledge or transfer its duties, obligations, and rights under this Contract, in whole or in part, without first obtaining the written consent of the CEO or their authorized representative. Any attempt by Contractor to assign or transfer its rights hereunder without such prior written consent shall, at the option of the CEO or their authorized representative, automatically terminate this Contract and all rights of Contractor hereunder.

**14. APPROPRIATIONS:**

Payment will be in accordance with the provisions of the Contract Documents, including Title 9 of the General Conditions, and will be made solely and exclusively from funds appropriated or otherwise lawfully made available for the purposes of this Contract from the Airport System Funds. The City has no obligation to make payments from any other fund or source or to make additional appropriations or allocations to such fund to satisfy such costs or other obligations.

**15. APPROVALS:**

In the event this Contract calls for the payment by the City of Five Million Dollars and no cents (\$5,000,000.00) or more, approval by the Denver City Council, acting by Resolution in accordance with Section 3.2.6 of the Charter of the City and County of Denver, is and shall be an express condition precedent to the lawful and binding execution and performance of this Contract.

**16. JOINT VENTURE:**

If Contractor is a Joint Venture, the partners to the Joint Venture shall be jointly and severally liable to the City for the performance of all duties and obligations of Contractor which are set forth in the Contract.

**17. NO DISCRIMINATION IN EMPLOYMENT:**

In connection with the performance of work under the Agreement, the Contractor may not refuse to hire, discharge, promote, demote, or discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, ethnicity, citizenship, immigration status, gender, age, sexual orientation, gender identity, gender expression, marital status, source of income, military status, protective hairstyle, or disability. The Contractor shall insert the foregoing provision in all subcontracts.

**18. COORDINATION OF SERVICES:**

Contractor agrees to perform its work under this Contract in accordance with the operational requirements of DEN, and all work and movement of personnel or equipment on areas included within the DEN site shall be subject to the regulations and restrictions established by the City or its authorized agents.

**19. COMPLIANCE WITH ALL LAWS AND REGULATIONS:**

**A.** Contractor and its subcontractor(s) shall perform all work under this Contract in compliance with all existing and future applicable laws, rules, regulations, and codes of the United States, and the State of Colorado and with the City Charter, ordinances, Executive Orders, and rules and regulations of the City.

**B.** Contractor shall perform all work in compliance with Executive Order 123 regarding Sustainability as may be directed by the City, including the requirement that all new City buildings and major renovations will be certified to the applicable LEED Gold Certification, with the goal of achieving LEED Platinum where economically feasible. Contractor also shall comply with all applicable DEN design and construction standards, including the DEN Design Standards Manuals, which are incorporated herein by reference. Current versions can be found at: <https://business.flydenver.com/bizops/bizRequirements.asp>.

**20. PREVAILING WAGE REQUIREMENTS:**

**A.** In addition to the Davis-Bacon Requirements contained in *Exhibit A*, Contractor shall comply with, and agrees to be bound by, all requirements, conditions and determinations of the City regarding the Payment of Prevailing Wages Ordinance, D.R.M.C. §§20-76 through 20-79, including, but not limited to, the requirement that every covered worker working on a City-owned or leased building or on City-owned land shall be paid no less than the prevailing wages and fringe benefits in effect on the date the bid or request for proposal was advertised. In the event a request for bids, or a request for proposal, was not advertised, Contractor shall pay every covered worker no less than the prevailing wages and fringe benefits in effect on the date funds for the Contract were encumbered.

Date bid or proposal issuance was advertised: January 27, 2023

If contract opportunity was not advertised, date of written encumbrance: N/A

**B.** Prevailing wage and fringe rates will adjust on the yearly anniversary of the actual date of bid or proposal issuance, if applicable, or the date of the written encumbrance if no bid/proposal issuance date is applicable. Unless expressly provided for in this Contract, Contractor will receive no additional compensation for increases in prevailing wages or fringe rates.

**C.** Contractor shall provide the Auditor of the City and County of Denver with a list of all subcontractors providing any services under the Contract.

**D.** Contractor shall provide the Auditor with electronically-certified payroll records for all covered workers employed under the Contract in a manner specified by the Auditor.

**E.** Contractor shall prominently post at the work site the current prevailing wage and fringe rates. The posting must inform workers that any complaints regarding the payment of prevailing wages or fringe benefits may be submitted to the Denver Auditor by calling 720-913-5000 or emailing [auditor@denvergov.org](mailto:auditor@denvergov.org).

**F.** If Contractor fails to pay workers as required by the Prevailing Wage Ordinance, Contractor will not be paid until documentation of payment satisfactory to the Auditor has been provided. The Auditor may enforce the Prevailing Wage Ordinance in a manner provided by law, including the Prevailing Wage Ordinance. The City also may, by written notice, suspend or terminate work if Contractor fails to pay required wages and fringe rates.

**21. CITY PROMPT PAYMENT:**

**A.** The City will make monthly progress payments to the Contractor for all services performed under this Contract based upon the Contractor’s monthly invoices or shall make payments as otherwise provided in this Agreement. The City’s Prompt Payment Ordinance, D.R.M.C. §§ 20-107 to 20-118, applies to invoicing and payment under this Contract.

**B.** Final Payment to the Contractor shall not be made until after the Project is accepted, and all certificates of completion, record drawings, reproducible copies, and other deliverables are delivered to the City, and the Contract is otherwise fully performed by the Contractor. The City may, at the discretion of the SVP, withhold reasonable amounts from billing and the entirety of the final payment until all such requirements are performed to the satisfaction of the SVP.

**C. Prompt Pay of DBE Subcontractors.** For contracts with federal funds to which Title 49 CFR §26.29 applies, Contractor is required to comply with the Prompt Payment provisions under Title 49 CFR §26.29, with regard to payments by Contractor to DBE subcontractors. Contractor shall make payment by no later than thirty (30) days from receipt by Contractor of the subcontractor’s invoice.

**22. OWNERSHIP AND DELIVERABLES:**

Upon payment to Contractor, all records, data, deliverables, and any other work product prepared by Contractor or any custom development work performed by Contractor for the purpose of performing this Contract on or before the day of the payment, whether a periodic or final payment, shall become the sole property of the City. Upon request by the City, or based on any schedule agreed to by Contractor and the City, Contractor shall provide the City with copies of the data/files that have been uploaded to any database maintained by or on behalf of Contractor or otherwise saved or maintained by Contractor as part of the services provided to the City under this Contract. All such data/files shall be provided to the City electronically in a format agreed to by the Parties. Contractor also agrees to allow the City to review any of the procedures Contractor uses in performing any work or other obligations under this Contract, and to make available for inspection any and all notes, documents, materials, and devices used in the preparation for or performance of any of the scope of work, for up to six (6) years after termination of this Contract. Upon written request from the City, Contractor shall deliver any information requested pursuant to this Section within ten (10) business days in the event a schedule or otherwise agreed-upon timeframe does not exist.

**23. COLORADO OPEN RECORDS ACT:**

**A.** Contractor acknowledges that the City is subject to the provisions of the Colorado Open Records Act (“**CORA**”), C.R.S. §§ 24-72-201 *et seq.*, and Contractor agrees that it will fully cooperate with the City in the event of a request or lawsuit arising under such act for the disclosure of any materials or information which Contractor asserts is confidential or otherwise exempt from disclosure. Any other provision of this Contract notwithstanding, all materials, records, and information provided by Contractor to the City shall be considered confidential by the City only to the extent provided in CORA, and Contractor agrees that any disclosure of information by the

City consistent with the provisions of CORA shall result in no liability of the City.

**B.** In the event of a request to the City for disclosure of such information, time and circumstances permitting, the City will make a good faith effort to advise Contractor of such request in order to give Contractor the opportunity to object to the disclosure of any material Contractor may consider confidential, proprietary, or otherwise exempt from disclosure. In the event Contractor objects to disclosure, the City, in its sole and absolute discretion, may file an application to the Denver District Court for a determination of whether disclosure is required or exempted. In the event a lawsuit to compel disclosure is filed, the City may tender all such material to the court for judicial determination of the issue of disclosure. In both situations, Contractor agrees it will either waive any claim of privilege or confidentiality or intervene in such legal process to protect materials Contractor does not wish disclosed. Contractor agrees to defend, indemnify, and hold harmless the City, its officers, agents, and employees from any claim, damages, expense, loss, or costs arising out of Contractor's objection to disclosure, including prompt reimbursement to the City of all reasonable attorney's fees, costs, and damages the City may incur directly or may be ordered to pay by such court, including but not limited to time expended by the City Attorney Staff, whose costs shall be computed at the rate specified in Section 5.

#### **24. EXAMINATION OF RECORDS AND AUDITS:**

**A.** Any authorized agent of the City, including the City Auditor or his or her representative, has the right to access, and the right to examine, copy and retain copies, at City's election in paper or electronic form, any pertinent books, documents, papers and records related to Contractor's performance pursuant to this Contract, provision of any goods or services to the City, and any other transactions related to this Contract. Contractor shall cooperate with City representatives and City representatives shall be granted access to the foregoing documents and information during reasonable business hours and until the latter of six (6) years after the final payment under the Contract or expiration of the applicable statute of limitations. When conducting an audit of this Contract, the City Auditor shall be subject to government auditing standards issued by the United States Government Accountability Office by the Comptroller General of the United States, including with respect to disclosure of information acquired during the course of an audit. No examination of records and audits pursuant to this paragraph shall require Contractor to make disclosures in violation of state or federal privacy laws. Contractor shall at all times comply with D.R.M.C. 20-276.

**B.** Additionally, Contractor agrees until the expiration of six (6) years after the final payment under this Contract, any duly authorized representative of the City, including the CEO or their representative, shall have the right to examine any pertinent books, documents, papers and records of Contractor related to Contractor's performance of this Contract, including communications or correspondence related to Contractor's performance, without regard to whether the work was paid for in whole or in part with federal funds or was otherwise related to a federal grant program.

**C.** In the event the City receives federal funds to be used toward the services performed under this Contract, the Federal Aviation Administration ("FAA"), the Comptroller

General of the United States and any other duly authorized representatives shall have access to any books, documents, papers and records of Contractor which are directly pertinent to a specific grant program for the purpose of making audit, examination, excerpts and transcriptions. Contractor further agrees that such records will contain information concerning the hours and specific services performed along with the applicable federal project number.

**25. MINIMUM WAGE REQUIREMENTS:**

To the extent required by law, Contractor shall comply with and agrees to be bound by all requirements, conditions, and City determinations regarding the City's Minimum Wage Ordinance, D.R.M.C. §§ 20-82 through 20-84, including, but not limited to, the requirement that every covered worker shall be paid no less than the City Minimum Wage in accordance with the City's Minimum Wage Ordinance. By executing this Contract, Contractor expressly acknowledges that Contractor is aware of the requirements of the City's Minimum Wage Ordinance and that any failure by Contractor, or any other individual or entity acting subject to this Contract, to strictly comply with the foregoing D.R.M.C. Sections shall result in the penalties and other remedies authorized therein.

**26. COMPLIANCE WITH DISADVANTAGED BUSINESS ENTERPRISE REQUIREMENTS:**

**A.** Department of Transportation (DOT), 49 C.F.R. Part 26 ("Part 26") applies to this Project and will be incorporated into any contract entered into by the City and contained in the City and County of Denver Bid Documents. The contractor, sub-recipient, or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate as further provided in Exhibit A. Consequently, Contractor must fully comply with the DBE requirements of Part 26 in bidding and performing hereunder.

**A.** Part 26 provides for the adoption of a good faith goals program, to be administered by the Division of Small Business Opportunity (DSBO). As such, each bidder must comply with the terms and conditions of the Part 26 in making its bid and, if awarded the Contract, in performing all Work thereunder. A bidder's failure to comply with Part 26, any Rules or Regulations promulgated pursuant thereto, or any additional requirements contained herein may render a bid non-responsive and may constitute cause for rejection.

**B.** In accordance with the requirements of the Part 26, the Contractor is committed to, at a minimum, meet the participation goal of **Twenty Four and One Tenth Percent (24.10%)** established for this Project utilizing properly certified DBE subcontractors and suppliers.

**27. SENSITIVE SECURITY INFORMATION:**

Contractor acknowledges that, in the course of performing its work under this Contract, Contractor may be given access to Sensitive Security Information (“SSI”), as material is described in the Code of Federal Regulations, 49 C.F.R. Part 1520. Contractor specifically agrees to comply with all requirements of the applicable federal regulations, including but not limited to, 49 C.F.R. Parts 15 and 1520. Contractor understands any questions it may have regarding its obligations with respect to SSI must be referred to DEN’s Security Office.

**28. DEN SECURITY:**

**A.** Contractor, its officers, authorized officials, employees, agents, subcontractors, and those under its control, shall comply with safety, operational, or security measures required of Contractor or the City by the FAA or TSA. If Contractor, its officers, authorized officials, employees, agents, subcontractors or those under its control, fail or refuse to comply with said measures and such non-compliance results in a monetary penalty being assessed against the City, then, in addition to any other remedies available to the City, Contractor shall fully reimburse the City any fines or penalties levied against the City, and any attorney fees or related costs paid by the City as a result of any such violation. Contractor must pay this amount within fifteen (15) days from the date of the invoice or written notice. Any fines and fees assessed by the FAA or TSA against the City due to the actions of Contractor and/or its agents will be deducted directly from the invoice for that billing period.

**B.** Contractor is responsible for compliance with Airport Security regulations and 49 C.F.R. Parts 1542 (Airport Security) and 14 C.R.F. Parts 139 (Airport Certification and Operations). Any and all violations pertaining to Parts 1542 and 139 resulting in a fine will be passed on to and borne by Contractor. The fee/fine will be deducted from the invoice at time of billing.

**29. FEDERAL RIGHTS:**

**A.** This Contract is subject and subordinate to the terms, reservations, restrictions and conditions of any existing or future contracts between the City and the United States, the execution of which has been or may be required as a condition precedent to the transfer of federal rights or property to the City for airport purposes, and the expenditure of federal funds for the extension, expansion or development of the Airport System.

(i) General Civil Rights: Contractor agrees to comply with pertinent statutes, Executive Orders and such rules as are promulgated to ensure that no person shall, on the grounds of race, creed, color, national origin, sex, age, or disability be excluded from participating in any activity conducted with or benefiting from Federal Assistance. This provision binds Contractor and subcontractors from the bid solicitation period through the completion of the Contract. This provision is in addition to that required of Title VI of the Civil Rights Act of 1964.

(ii) Federal Fair Labor Standards Act: This Contract incorporates by reference the provisions of 29 C.F.R. Part 201, the Federal Fair Labor Standards Act (“FLSA”), with

the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers. Contractor agrees to incorporate by reference the provisions of FLSA in all contracts and subcontracts resulting from this Contract. Contractor has full responsibility to monitor compliance to the referenced regulation. Contractor must address any claims or disputes arising from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

(iii) Occupational Safety and Health Act: This Contract incorporates by reference the requirements of 29 C.F.R. Part 1910 with the same force and effect as if given in full text. Contractor must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. Contractor retains full responsibility to monitor its compliance and any subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (29 C.F.R. Part 1910). Contractor must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

(iv) Contractor covenants it will include the provisions of this section in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Federal Acts, Regulations and directives issued pursuant thereto. Contractor covenants it will take action with respect to any subcontract or procurement as the City or the FAA may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if Contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, Contractor may request the City to enter into any litigation to protect the interests of the City. In addition, Contractor may request the United States to enter into the litigation to protect the interests of the United States.

### **30. CITY EXECUTION OF CONTRACT:**

This Contract is expressly subject to, and shall become effective upon, the execution of all signatories of the City and, if required, the approval of Denver City Council. This Contract may be executed in two or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same.

### **31. ELECTRONIC SIGNATURES AND ELECTRONIC RECORDS:**

The Contract, and any other documents requiring a signature hereunder, may be signed electronically by the City and/or Contractor in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Contract solely because it is in electronic form or because an electronic record was used in its formation. The Parties agree not to object to the admissibility of the Contract in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

**[SIGNATURE PAGES FOLLOW]**

**Contract Control Number:** PLANE-202366450-00  
**Contractor Name:** ANY VENDOR

IN WITNESS WHEREOF, the parties have set their hands and affixed their seals at Denver, Colorado as of:

**SEAL**

**CITY AND COUNTY OF DENVER:**

**ATTEST:**

By:

\_\_\_\_\_

\_\_\_\_\_

**APPROVED AS TO FORM:**

**REGISTERED AND COUNTERSIGNED:**

Attorney for the City and County of Denver

By:

By:

\_\_\_\_\_

\_\_\_\_\_

By:

\_\_\_\_\_

**Contract Control Number:**  
**Contractor Name:**

PLANE-202366450-00  
ANY VENDOR

By: DocuSigned by:  
*Grant Johns*  
DE0C339A96D14DC...

Name: Grant Johns  
(please print)

Title: Vice President & District Manager  
(please print)

ATTEST: [if required]

By: DocuSigned by:  
*Kevin McCormick*  
CBB144F0B7CB480...

Name: Kevin McCormick  
(please print)

Title: Central Division Finance Manager  
(please print)

## **EXHIBIT A**

### **FEDERAL CONSTRUCTION CONTRACT PROVISIONS**

#### **A1.3 ACCESS TO RECORDS AND REPORTS**

The Contractor must maintain an acceptable cost accounting system. The Contractor agrees to provide the Owner, the Federal Aviation Administration and the Comptroller General of the United States or any of their duly authorized representatives access to any books, documents, papers and records of the Contractor which are directly pertinent to the specific contract for the purpose of making audit, examination, excerpts and transcriptions. The Contractor agrees to maintain all books, records and reports required under this contract for a period of not less than three years after final payment is made and all pending matters are closed.

#### **A3.3 BREACH OF CONTRACT TERMS**

Any violation or breach of terms of this contract on the part of the Contractor or its subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this agreement. The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder are in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law.

#### **A4.3.1 BUY AMERICAN PREFERENCE**

The Contractor agrees to comply with 49 USC § 50101, which provides that Federal funds may not be obligated unless all steel and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list.

A bidder or offeror must complete and submit the Buy America certification included with the Invitation to Bid or other solicitation with their bid or offer.

#### **A6.4.1 TITLE VI CLAUSES FOR COMPLIANCE WITH NONDISCRIMINATION REQUIREMENTS**

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor"), agrees as follows:

1. **Compliance with Regulations:** The Contractor (hereinafter includes consultants) will comply with the Title VI List of Pertinent Nondiscrimination Acts and Authorities, as they may be amended from time to time, which are herein incorporated by reference and made a part of this contract.

2. **Nondiscrimination:** The Contractor, with regard to the work performed by it during the contract, will not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor will not participate directly or indirectly in the discrimination prohibited by the Nondiscrimination Acts and Authorities, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR part 21.
3. **Solicitations for Subcontracts, including Procurements of Materials and Equipment:** In all solicitations, either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier will be notified by the Contractor of the contractor's obligations under this contract and the Nondiscrimination Acts and Authorities on the grounds of race, color, or national origin.
4. **Information and Reports:** The Contractor will provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the sponsor or the Federal Aviation Administration to be pertinent to ascertain compliance with such Nondiscrimination Acts and Authorities and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information, the Contractor will so certify to the sponsor or the Federal Aviation Administration, as appropriate, and will set forth what efforts it has made to obtain the information.
5. **Sanctions for Noncompliance:** In the event of a Contractor's noncompliance with the non-discrimination provisions of this contract, the sponsor will impose such contract sanctions as it or the Federal Aviation Administration may determine to be appropriate, including, but not limited to:
  - a. Withholding payments to the Contractor under the contract until the Contractor complies; and/or
  - b. Cancelling, terminating, or suspending a contract, in whole or in part.
6. **Incorporation of Provisions:** The Contractor will include the provisions of paragraphs one through six in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations, and directives issued pursuant thereto. The Contractor will take action with respect to any subcontract or procurement as the sponsor or the Federal Aviation Administration may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if the Contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, the Contractor may request the sponsor to enter into any litigation to protect the interests of the sponsor. In addition, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

#### **A6.4.5 TITLE VI LIST OF PERTINENT NONDISCRIMINATION ACTS AND AUTHORITIES**

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the “Contractor”) agrees to comply with the following non-discrimination statutes and authorities; including but not limited to:

- Title VI of the Civil Rights Act of 1964 (42 USC § 2000d *et seq.*, 78 stat. 252) (prohibits discrimination on the basis of race, color, national origin);
- 49 CFR part 21 (Non-discrimination in Federally-assisted programs of the Department of Transportation—Effectuation of Title VI of the Civil Rights Act of 1964);
- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 USC § 4601) (prohibits unfair treatment of persons displaced or whose property has been acquired because of Federal or Federal-aid programs and projects);
- Section 504 of the Rehabilitation Act of 1973 (29 USC § 794 *et seq.*), as amended (prohibits discrimination on the basis of disability); and 49 CFR part 27;
- The Age Discrimination Act of 1975, as amended (42 USC § 6101 *et seq.*) (prohibits discrimination on the basis of age);
- Airport and Airway Improvement Act of 1982 (49 USC § 471, Section 47123), as amended (prohibits discrimination based on race, creed, color, national origin, or sex);
- The Civil Rights Restoration Act of 1987 (PL 100-209) (broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, the Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms “programs or activities” to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);
- Titles II and III of the Americans with Disabilities Act of 1990, which prohibit discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities (42 USC §§ 12131 – 12189) as implemented by U.S. Department of Transportation regulations at 49 CFR parts 37 and 38;
- The Federal Aviation Administration’s Nondiscrimination statute (49 USC § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which ensures nondiscrimination against minority populations by discouraging programs, policies, and activities with disproportionately high and adverse human health or environmental effects on minority and low-income populations;
- Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, and resulting agency guidance, national origin discrimination

includes discrimination because of limited English proficiency (LEP). To ensure compliance with Title VI, you must take reasonable steps to ensure that LEP persons have meaningful access to your programs (70 Fed. Reg. at 74087 to 74100);

- Title IX of the Education Amendments of 1972, as amended, which prohibits you from discriminating because of sex in education programs or activities (20 USC 1681 et seq).

### **A7.3 CLEAN AIR AND WATER POLLUTION CONTROL**

Contractor agrees to comply with all applicable standards, orders, and regulations issued pursuant to the Clean Air Act (42 USC § 740-7671q) and the Federal Water Pollution Control Act as amended (33 USC § 1251-1387). The Contractor agrees to report any violation to the Owner immediately upon discovery. The Owner assumes responsibility for notifying the Environmental Protection Agency (EPA) and the Federal Aviation Administration.

Contractor must include this requirement in all subcontracts that exceeds \$150,000.

### **A8.3 CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS**

#### **1. Overtime Requirements.**

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic, including watchmen and guards, in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

#### **2. Violation; Liability for Unpaid Wages; Liquidated Damages.**

In the event of any violation of the clause set forth in paragraph (1) of this clause, the Contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1) of this clause, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1) of this clause.

#### **3. Withholding for Unpaid Wages and Liquidated Damages.**

The Federal Aviation Administration (FAA) or the Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or

subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2) of this clause.

4. Subcontractors.

The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs (1) through (4) and also a clause requiring the subcontractor to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1) through (4) of this clause.

### **A9.3 COPELAND “ANTI-KICKBACK” ACT**

Contractor must comply with the requirements of the Copeland “Anti-Kickback” Act (18 USC 874 and 40 USC 3145), as supplemented by Department of Labor regulation 29 CFR part 3. Contractor and subcontractors are prohibited from inducing, by any means, any person employed on the project to give up any part of the compensation to which the employee is entitled. The Contractor and each Subcontractor must submit to the Owner, a weekly statement on the wages paid to each employee performing on covered work during the prior week. Owner must report any violations of the Act to the Federal Aviation Administration.

### **A10.3 DAVIS-BACON REQUIREMENTS**

1. Minimum Wages.

- (i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Secretary of Labor under the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalent thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and

mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided* that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can easily be seen by the workers.

- (ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:
  - (1) The work to be performed by the classification requested is not performed by a classification in the wage determination;
  - (2) The classification is utilized in the area by the construction industry; and
  - (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
- (B) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
- (C) In the event the Contractor, the laborers, or mechanics to be employed in the classification, or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt

and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

- (D) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(ii) (B) or (C) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.
- (iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
- (iv) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program: *Provided* that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

## 2. Withholding.

The Federal Aviation Administration or the sponsor shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of work, all or part of the wages required by the contract, the Federal Aviation Administration may, after written notice to the Contractor, Sponsor, Applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

## 3. Payrolls and Basic Records.

- (i) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 1(b)(2)(B) of the Davis-Bacon Act); daily and

weekly number of hours worked; deductions made; and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records that show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and that show the costs anticipated or the actual costs incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

- (ii)(A) The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit the payrolls to the applicant, Sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (*e.g.* the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at [www.dol.gov/whd/forms/wh347instr.htm](http://www.dol.gov/whd/forms/wh347instr.htm) or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker and shall provide them upon request to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit them to the applicant, sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration, the Contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, Sponsor, or Owner).
- (B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

- (1) The payroll for the payroll period contains the information required to be provided under 29 CFR § 5.5(a)(3)(ii), the appropriate information is being maintained under 29 CFR § 5.5 (a)(3)(i), and that such information is correct and complete;
  - (2) Each laborer and mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations 29 CFR Part 3;
  - (3) Each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
- (C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the “Statement of Compliance” required by paragraph (3)(ii)(B) of this section.
- (D) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.
- (ii) The Contractor or subcontractor shall make the records required under paragraph (3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the sponsor, the Federal Aviation Administration, or the Department of Labor and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, Sponsor, applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

#### 4. Apprentices and Trainees.

- (i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of

Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- (ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination that provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate that is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable

wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- (iii) Equal Employment Opportunity. The utilization of apprentices, trainees, and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

5. Compliance with Copeland Act Requirements.

The Contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

6. Subcontracts.

The Contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR Part 5.5(a)(1) through (10) and such other clauses as the Federal Aviation Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR Part 5.5.

7. Contract Termination: Debarment.

A breach of the contract clauses in paragraph 1 through 10 of this section may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act Requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes Concerning Labor Standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any

of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

- (i) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 USC 1001.

**A11.3.2 CERTIFICATION OF LOWER TIER CONTRACTORS REGARDING DEBARMENT**

Contractor, by administering each lower tier subcontract that exceeds \$25,000 as a "covered transaction", must verify each lower tier participant of a "covered transaction" under the project is not presently debarred or otherwise disqualified from participation in this federally assisted project. Contractor will accomplish this by:

1. Checking the System for Award Management at website: <http://www.sam.gov>.
2. Collecting a certification statement similar to the Certification of Offerer /Bidder Regarding Debarment, above.
3. Inserting a clause or condition in the covered transaction with the lower tier contract.

If the Federal Aviation Administration later determines that a lower tier participant failed to disclose to a higher tier participant that it was excluded or disqualified at the time it entered the covered transaction, the FAA may pursue any available remedies, including suspension and debarment of the non-compliant participant.

**A12.3.3 PRIME CONTRACTS (PROJECTS COVERED BY A DBE PROGRAM) DISADVANTAGED BUSINESS ENTERPRISES**

The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of Department of Transportation-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the Owner deems appropriate, which may include, but is not limited to:

- 1) Withholding monthly progress payments;
- 2) Assessing sanctions;
- 3) Liquidated damages; and/or
- 4) Disqualifying the Contractor from future bidding as non-responsible.

**Prompt Payment (§26.29) –**

The prime contractor agrees to pay each subcontractor under this prime contract for satisfactory performance of its contract no later than 30 days from the receipt of each payment the prime contractor receives from the City and County of Denver. The prime contractor agrees further to return retainage payments to each subcontractor within 30 days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time frame may occur only for good cause following written approval of the City and County of Denver. This clause applies to both DBE and non-DBE subcontractors.

**A13.3 TEXTING WHEN DRIVING**

In accordance with Executive Order 13513, "Federal Leadership on Reducing Text Messaging While Driving", (10/1/2009) and DOT Order 3902.10, "Text Messaging While Driving", (12/30/2009), the Federal Aviation Administration encourages recipients of Federal grant funds to adopt and enforce safety policies that decrease crashes by distracted drivers, including policies to ban text messaging while driving when performing work related to a grant or subgrant.

In support of this initiative, the Owner encourages the Contractor to promote policies and initiatives for its employees and other work personnel that decrease crashes by distracted drivers, including policies that ban text messaging while driving motor vehicles while performing work activities associated with the project. The Contractor must include the substance of this clause in all sub-tier contracts exceeding \$3,500 that involve driving a motor vehicle in performance of work activities associated with the project.

**A14.3 ENERGY CONSERVATION REQUIREMENTS**

Contractor and Subcontractor agree to comply with mandatory standards and policies relating to energy efficiency as contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 USC 6201 *et seq*).

**A16.3.1 EQUAL EMPLOYMENT OPPORTUNITY CLAUSE**

During the performance of this contract, the Contractor agrees as follows:

- (1) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to, the following:

employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff, or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

- (2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
- (3) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the Contractor's commitments under this section and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- (4) The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- (5) The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
- (6) In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.
- (7) The Contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however*, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

### **A16.3.2 STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS**

1. As used in these specifications:
  - a. “Covered area” means the geographical area described in the solicitation from which this contract resulted;
  - b. “Director” means Director, Office of Federal Contract Compliance Programs (OFCCP), U.S. Department of Labor, or any person to whom the Director delegates authority;
  - c. “Employer identification number” means the Federal social security number used on the Employer’s Quarterly Federal Tax Return, U.S. Treasury Department Form 941;
  - d. “Minority” includes:
    - (1) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
    - (2) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin regardless of race);
    - (3) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
    - (4) American Indian or Alaskan native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).
2. Whenever the Contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.
3. If the Contractor is participating (pursuant to 41 CFR part 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors shall be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved plan is individually required to comply with its obligations under the EEO clause and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does

not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7a through 7p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in a geographical area where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.
5. Neither the provisions of any collective bargaining agreement nor the failure by a union with whom the Contractor has a collective bargaining agreement to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.
6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees shall be employed by the Contractor during the training period and the Contractor shall have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees shall be trained pursuant to training programs approved by the U.S. Department of Labor.
7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully and shall implement affirmative action steps at least as extensive as the following:
  - a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other onsite supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
  - b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

- c. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore along with whatever additional actions the Contractor may have taken.
- d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or female sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.
- e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.
- f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
- g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination, or other employment decisions, including specific review of these items, with onsite supervisory personnel such as superintendents, general foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
- h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other contractors and subcontractors with whom the Contractor does or anticipates doing business.

- i. Direct its recruitment efforts, both oral and written, to minority, female, and community organizations, to schools with minority and female students; and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations, such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
  - j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a contractor's workforce.
  - k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.
  - l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel, for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
  - m. Ensure that seniority practices, job classifications, work assignments, and other personnel practices do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.
  - n. Ensure that all facilities and company activities are non-segregated except that separate or single user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
  - o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
  - p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.
8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative action obligations (7a through 7p). The efforts of a contractor association, joint contractor union, contractor community, or other similar groups of which the Contractor is a member and participant may be asserted as fulfilling any one or more of its obligations under 7a through 7p of these specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and

female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, if the particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally), the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized.
10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.
11. The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246. 12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.
13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR part 60-4.8.
14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government, and to keep records. Records shall at least include for each employee, the name, address, telephone number, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g. those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

### **A17 FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)**

This Contract incorporates by reference the provisions of 29 CFR part 201, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers.

The Contractor has full responsibility to monitor compliance to the referenced statute or regulation. The Contractor must address any claims or disputes that arise from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

### **A18.3 CERTIFICATION REGARDING LOBBYING**

The Bidder or Offeror certifies by signing and submitting its bid or proposal, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

### **A19.3 PROHIBITION OF SEGREGATED FACILITIES**

- (a) The Contractor agrees that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Contractor agrees that a breach of this clause is a violation of the Equal Employment Opportunity clause in this contract.
- (b) “Segregated facilities,” as used in this clause, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, or national origin because of written or oral policies or employee custom. The term does not include separate or single-user rest rooms or necessary dressing or sleeping areas provided to assure privacy between the sexes.
- (c) The Contractor shall include this clause in every subcontract and purchase order that is subject to the Equal Employment Opportunity clause of this contract.

### **A20.3 OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970**

This Contract incorporates by reference the requirements of 29 CFR Part 1910 with the same force and effect as if given in full text. The employer must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. The employer retains full responsibility to monitor its compliance and their subcontractor’s compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (20 CFR Part 1910). The employer must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

### **A21.3 PROCUREMENT OF RECOVERED MATERIALS**

Contractor and subcontractor agree to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, and the regulatory provisions of 40 CFR Part 247. In the performance of this contract and to the extent practicable, the Contractor and subcontractors are to use products containing the highest percentage of recovered materials for items designated by the Environmental Protection Agency (EPA) under 40 CFR Part 247 whenever:

- 1) The contract requires procurement of \$10,000 or more of a designated item during the fiscal year; or
- 2) The contractor has procured \$10,000 or more of a designated item using Federal funding during the previous fiscal year.

The list of EPA-designated items is available at [www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products](http://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products).

Section 6002(c) establishes exceptions to the preference for recovery of EPA-designated products if the contractor can demonstrate the item is:

- a) Not reasonably available within a timeframe providing for compliance with the contract performance schedule;
- b) Fails to meet reasonable contract performance requirements; or
- c) Is only available at an unreasonable price.

### **A22.3 RIGHTS TO INVENTIONS**

Contracts or agreements that include the performance of experimental, developmental, or research work must provide for the rights of the Federal Government and the Owner in any resulting invention as established by 37 CFR part 401, Rights to Inventions Made by Non-profit Organizations and Small Business Firms under Government Grants, Contracts, and Cooperative Agreements. This contract incorporates by reference the patent and inventions rights as specified within 37 CFR §401.14. Contractor must include this requirement in all sub-tier contracts involving experimental, developmental, or research work.

#### **A23.3.2 SEISMIC SAFETY**

The Contractor agrees to ensure that all work performed under this contract, including work performed by subcontractors, conforms to a building code standard that provides a level of seismic safety substantially equivalent to standards established by the National Earthquake Hazards Reduction Program (NEHRP). Local building codes that model their code after the current version of the International Building Code (IBC) meet the NEHRP equivalency level for seismic safety.

### **A24.3 CERTIFICATION OF OFFERER/BIDDER REGARDING TAX DELINQUENCY AND FELONY CONVICTIONS**

Contractor's Certification regarding Tax Delinquency and Felony Convictions, submitted with its bid or proposal, is incorporated by reference as if fully restated herein. No Federal funds shall be paid to any contractor who has been convicted of a Federal felony within the last 24 months; or who has any outstanding tax liability for which all judicial and administrative remedies have lapsed or been exhausted.

#### **A25.3.2 TERMINATION FOR DEFAULT (CONSTRUCTION)**

Section 80-09 of FAA Advisory Circular 150/5370-10 establishes conditions, rights, and remedies associated with Owner termination of this contract due to default of the Contractor.

### **A27.3 VETERAN'S PREFERENCE**

In the employment of labor (excluding executive, administrative, and supervisory positions), the Contractor and all sub-tier contractors must give preference to covered veterans as defined within Title 49 United States Code Section 47112. Covered veterans include Vietnam-era veterans, Persian Gulf veterans, Afghanistan-Iraq war veterans, disabled veterans, and small business concerns (as defined by 15 USC 632) owned and controlled by disabled veterans. This preference only applies when there are covered veterans readily available and qualified to perform the work to which the employment relates.

**EXHIBIT B**

**CITY AND COUNTY OF DENVER  
RULES AND REGULATIONS AND BID  
CONDITIONS OF THE  
MANAGER OF PUBLIC WORKS**

**PERTAINING TO EQUAL EMPLOYMENT OPPORTUNITY  
IN THE CITY AND COUNTY OF DENVER**

APPROVED FOR LEGALITY:

APPROVED AND ADOPTED:

/s/ \_\_\_\_\_  
Attorney for the City and  
County of Denver

/s/ \_\_\_\_\_  
Manager of Public Works

Adopted and Published Pursuant to Article 111, Division 2 of Chapter 28  
the Revised Municipal Code  
of the City and County of Denver

These Rules and Regulations cancel and supersede any and all previous issued Rules and  
Regulations on the subject

Vendor Name

Contract No. xxxxxxxxxxx-xx

**RULES AND REGULATIONS**  
**REGARDING**  
**EQUAL EMPLOYMENT OPPORTUNITY**

Promulgated and adopted by the Manager of Public Works pursuant to and by authority of Article III, Division 2, Chapter 28 of the Revised Municipal Code of the City and County of Denver, and for the purpose of insuring that contractors, subcontractors and suppliers soliciting and receiving compensation for contract work from or through the City and County of Denver provide equal opportunity in employment without regard to race, color, creed, sex, national origin, age, religion, marital status, political opinion or affiliation or mental or physical handicap and meet certain requirements for the hiring, training, promotion and treatment during employment of members of ethnic groups subjected to differential treatment, including persons of African descent (Black), Spanish-surnamed (Hispanic), Asian-American and American Indian groups.

**RULE I**  
**DEFINITIONS**

- A. "City" means the City and County of Denver.
- B. "Manager" shall mean the Manager of Public Works for the City and County of Denver.
- C. "Contract" means a contract entered into with the City and County of Denver, financed in whole or in part by local resources or funds of the City and County of Denver, for the construction of any public building or prosecution or completion of any public work.
- D. "Contractor" means the original party to a contract with the City and County of Denver, also referred to as the "general" or "prime" contractor.
- E. "Director" means the Director of the Mayor's Office of Contract Compliance.
- F. "Subcontractor" means any person, company, association, partnership, corporation, or other entity which assumes by subordinate agreement some or all of the obligations of the general or prime contractor.
- G. The Phrase "Bidding Specifications" as used in Article 111, Division 2 of Chapter 28 of the Revised Municipal Code shall include BID CONDITION, INVITATION TO BID AND NOTICE OF PROPOSAL.
- H. "Affirmative Action Program" means a set of specific and result-oriented procedures or steps to which a contractor commits himself to apply every good faith effort to employ members of ethnic minority groups, to include persons of African descent (Black), Spanish surnamed (Hispanic), Asian-American, American Indians, and persons with mental or physical handicap.
- I. "Mayor's Office of Contract Compliance" means the City agency established pursuant to Article III, Division 1 of Chapter 28 of the Denver Revised Municipal Code.

**RULE II**  
**NOTICE OF HEARING**

When results of conciliation efforts are unsatisfactory to the Manager and he is informed in accordance with Article III, Division 2 of Chapter 28 of the Revised Municipal Code that a contractor or subcontractor has apparently failed to meet affirmative action and equal employment opportunity requirements after a reasonable period of notice to correct deficiencies, the Manager will, prior to imposition of any sanctions, afford the general contractor a hearing in order to determine whether the contractor or his subcontractors have failed to comply with the affirmative action and equal employment opportunity requirements of Article III, Division 2 of Chapter 28 of the Revised Municipal Code or of the contract. Written notice of such hearing shall be delivered personally or sent by certified mail return receipt requested, to the contractor and to any subcontractor involved at least ten days prior to the date scheduled for the hearing.

**RULE III**  
**HEARING**

- A. Contractors will appear at hearings and may be represented by counsel, and may present testimony orally and other evidence.
- B. Hearings shall be conducted by one or more hearing examiners designated as such by the Manager.
- C. The Director of the Mayor's Office of Contract Compliance may participate in hearings as a witness.
- D. Hearings shall be held at the place specified in the notice of hearing.
- E. All oral testimony shall be given under oath or affirmation and a record of such proceedings shall be made.
- F. All hearings shall be open to the public.
- G. The hearing officer shall make recommendations to the Manager who shall make a final decision.

**REGULATIONS**

**REGULATION NO. 1. ORDINANCE:** The Rules and Regulations of the Manager shall be inserted in the bidding specifications for every contract for which bidding is required.

**REGULATION NO. 2. EXEMPTIONS:** Each contract and subcontract, regardless of dollar amount, shall be subject to affirmative action requirements unless specifically exempted in writing individually by the Manager. Exemptions apply only to "affirmative action" in equal employment opportunity, and are not to be construed as condonation in any manner of "discrimination" or "discriminatory practices" in employment because of race, color, creed sex age national origin, religion, marital status, political opinion or mental or physical handicap.

Vendor Name

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**REGULATION NO. 3. DIRECTOR OF CONTRACT COMPLIANCE:** The Director of the Mayor's Office of Contract Compliance shall perform the duties assigned to such official by Article III, Division 2 of Chapter 28 of the Revised Municipal Code and by the Manager. (1) The Director of the Mayor's Office of Contract Compliance or designated representatives shall inform bidders and contractors of affirmative action procedures, programs, and goals in accordance with the ordinance at pre-bid and pre-construction conference; (2) make regular on-site inspections; (3) supply contractors and subcontractors with report forms to be completed by them when requested, and furnished to the Director of the Mayor's Office of Contract Compliance; and (4) review payroll records, employment records and practices of general contractors and their subcontractors and suppliers during the performance of any contract. The Director of the Mayor's Office of Contract Compliance shall promptly report apparent affirmative action deficiencies to the Manager.

**REGULATION NO. 4. GOALS AND TIMETABLES:** In general, goals and timetables should take into account anticipated vacancies and the availability of skills in the market place from which employees should be drawn. In addition, where discrimination in employment by a general contractor or any of his subcontractors is indicated, a corrective action program will take into account the need by the general contractor and his subcontractors to correct past discriminatory practices and reach goals of minority manpower utilization on a timely basis through such recruiting and advertising efforts as are necessary and appropriate.

**REGULATION NO.5. AWARD OF CONTRACTS:** It shall be the responsibility of the Director of the Mayor's Office of Contract Compliance to determine the affirmative action capability of bidders, contractors and subcontractors and to recommend to the Manager the award of contracts to those bidders, contractors and subcontractors and suppliers who demonstrate the ability and willingness to comply with the terms of their contract.

**REGULATION NO. 6. PUBLICATION AND DUPLICATION:** Copies of these Rules and Regulations as amended by the Manager from time to time, shall as soon as practicable and after Notice being published will be made a part of all City Contracts.

**REGULATION NO. 7. NOTICE TO PROCEED:** Prior to issuance of Notice to Proceed a sign-off will be required of the Director of the Mayor's Office of Contract Compliance or his designee.

**REGULATION NO. 8. CONTRACTS WITH SUBCONTRACTORS:** To the greatest extent possible the contractor shall make a good faith effort to contract with minority contractors, subcontractors and suppliers for services and supplies by taking affirmative actions which include but are not limited to the following:

1. Advertise invitations for subcontractor bids in minority community news media.
2. Contact minority contractor organizations for referral of prospective subcontractors.
3. Purchase materials and supplies from minority material suppliers.

**REGULATION NO. 9. AGENCY REFERRALS:** it shall be no excuse that the union with which the contractor or subcontractor has an agreement providing for referral, exclusive or otherwise, failed to refer minority employees.

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**REGULATION NO. 10. CLAUSES:** The Manager shall include the appropriate clauses in every contract and the contractor shall cause to be inserted in every subcontract the appropriate clauses:

1. **APPENDIX A:** City and County of Denver Equal Opportunity Clause-ALL CONTRACTS funded only with City & County of Denver monies.
2. **APPENDIX B:** Equal Opportunity Clause (11246)-ALL FEDERAL ASSISTED
3. **APPENDIX C:** Section 3-Assurance of Compliance-HUD ASSISTED PROJECTS.
4. **APPENDIX D:** Section 3-Clause-HUD ASSISTED PROJECTS.

All amendments to the appendices shall be included by reference.

**REGULATION NO. 11. SHOW CAUSE NOTICES:** When the Manager has reasonable cause to believe that a contractor has violated Article III, Division 2 of Chapter 28 of the Revised Municipal Code, he may issue a notice requiring the contractor to show cause, within fifteen days why enforcement procedures, or other appropriate action to insure compliance, should not be instituted.

**REGULATION NO. 12. BID CONDITIONS-AFFIRMATIVE ACTION REQUIREMENTS-EQUAL EMPLOYMENT OPPORTUNITY:**

**1. APPENDIX E:**

The Bid Conditions- Affirmative Action Requirements-Equal Employment Opportunity as amended and published by the U.S. Department of Labor, Employment Standards Administration, Office of Federal Contract Compliance, shall be inserted verbatim for bidding specification for every non-exempt contract involving the use of Federal funds.

**2. APPENDIX F:**

The Bid Conditions- Affirmative Action Requirements-Equal Employment Opportunity as published by the Department of Public Works, City and County of Denver shall be inserted verbatim as bidding specifications for every non-exempt contract using City funds.

**APPENDIX A**

**CITY AND COUNTY OF DENVER EQUAL OPPORTUNITY CLAUSE-ALL CONTRACTS**

1. The contractor will not discriminate against any employee or applicant for employment because of race creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap.
3. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Each contractor will comply with all provisions of Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager and Director.
5. The contractor will furnish all information and reports required by Article III, Division 2, Chapter 28 of the Revised Municipal Code, and by rules, regulations and orders of the Manager and Director or pursuant thereto, and will permit access to his books, records, and accounts by the Manager, Director or their designee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations or orders this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further City contracts in accordance with procedures authorized in Article III, Division 2, Chapter 28 of the Revised Municipal Code, or by rules, regulations, or order of the Manager.
7. The contractor will include Regulation 12 Paragraph 2 and the provisions of paragraphs (1) through (6) in every subcontract or purchase order unless, exempted by rules, regulations, or orders of the Manager issued pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, so that such provisions will be binding upon each subcontractor or suppliers. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance.

Vendor Name

Contract No. xxxxxxxxxxx-xx

The applicant further agrees to be bound by the above equal opportunity clauses with respect to its own employment practices when it participates in City contracts. The contractor agrees to assist and cooperate actively with the Manager and the Director in obtaining compliance of subcontractors and suppliers with the equal opportunity clause and the rules, regulations and relevant orders of the Manager, and will furnish the Manager and the Director such information as they may require for the supervision of compliance, and will otherwise assist the Manager and Director in the discharge of the City's primary responsibility for securing compliance. The contractor further agrees to refrain from entering into any contract or contract modification subject to Article III, Division 2, Chapter 28 of the Revised Municipal Code with a contractor debarred from, or who has not demonstrated eligibility for, City contracts.

The contractor will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the Manager and Director. In addition, the contractor agrees that failure or refusal to comply with these undertakings the Manager may take any or all of the following actions:

- A. Cancellation, termination, or suspension in whole or in part of this contract.
- B. Refrain from extending any further assistance to the applicant under the program with respect to which the failure occurred until satisfactory assurance of future compliance has been received from such applicant.
- C. Refer the case to the City Attorney for appropriate legal proceedings.

**SUBCONTRACTS:** Each prime contractor or subcontractor shall include the equal opportunity clause in each of its subcontracts.

**APPENDIX F  
BID CONDITIONS  
AFFIRMATIVE ACTION REQUIREMENTS  
EQUAL EMPLOYMENT OPPORTUNITY**

For all Non-Exempt Construction Contracts to be Awarded by  
the City and County of Denver, Department of Public Works

**NOTICE**

EACH BIDDER, CONTRACTOR OR SUBCONTRACTOR (HEREINAFTER THE CONTRACTOR) MUST FULLY COMPLY WITH THE REQUIREMENTS OF THESE BID CONDITIONS AS TO EACH CONSTRUCTION TRADE IT INTENDS TO USE ON THIS CONSTRUCTION CONTRACT, AND ALL OTHER CONSTRUCTION WORK (BOTH CITY AND NON-CITY) IN THE DENVER AREA DURING THE PERFORMANCE OF THIS CONTRACT OR SUBCONTRACT. THE CONTRACTOR COMMITS ITSELF TO THE GOALS FOR MINORITY MANPOWER UTILIZATION, AS APPLICABLE, AND ALL OTHER REQUIREMENTS, TERMS AND CONDITION OF THESE BID CONDITIONS BY SUBMITTING A PROPERLY SIGNED BID.

THE CONTRACTOR SHALL APPOINT A COMPANY EXECUTIVE TO ASSUME THE RESPONSIBILITY FOR THE IMPLEMENTATION OF THE REQUIREMENTS, TERMS AND CONDITIONS OF THESE BID CONDITIONS.

EULOIS CLECKLEY  
Manager of Public Works  
City and County of Denver

Vendor Name

Contract No. xxxxxxxxxxx-xx

**A. REQUIREMENTS --AN AFFIRM ATIVE ACTION PLAN:**

Contractors shall be subject to the provisions and requirements of these bid conditions including the goals and timetables for minority' and female utilization, and specific affirmative action steps set forth by the Office of Contract Compliance. The contractor's commitment to the goals for minority, and female utilization as required constitutes a commitment that it will make every good faith effort to meet such goals.

**1. GOALS AND TIMETABLES:**

The goals and timetables for minority<sup>1</sup> and female participation, expressed in percentage terms for the contractor's aggregate workforce in each trade are as follows:

**GOALS FOR MINORITY PARTICIPATION FOR EACH TRADE**

From January 1, 1982  
to 21.7% - 23.5%  
Until Further Notice

**GOALS FOR FEMALE PARTICIPATION FOR EACH TRADE**

From January 1, 1982  
to 6.9%  
Until Further Notice

The goals for minority and female utilization above are expressed in terms of hours of training and employment as a proportion of the total number of hours to be worked by the contractor's aggregate workforce, which includes all supervisory personnel, in each trade, on all projects for the City and County of Denver during the performance of its contract (i.e., The period beginning with the first day of work on the City and County of Denver funded construction contract and ending with the last day of work).

The hours of minority and female employment and training must be substantially uniform throughout the length of the contract in each trade and minorities and females must be employed evenly on each of a contractor's projects. Therefore, the transfer of minority or female employees from contractor to contractor or from project to project for the purpose of meeting the contractor's goals shall be a violation of these Bid Conditions.

If the contractor counts the nonworking hours of apprentices they must be employed by the contractor during the training period; the contractor must have made a commitment to employ apprentices at the completion of their training subject to the availability of employment opportunities; and the apprentices must be trained pursuant to training programs approved by the Bureau of Apprenticeship and Training.

<sup>1</sup> "Minority" is defined as including, Blacks, Spanish Surname Americans, Asian-Americans, and American Indians, and includes both men and Minority women.

## 2. **SPECIFIC AFFIRMATIVE ACTION STEPS:**

No contractor shall be found to be in noncompliance solely on account of its failure to meet its goals, but will be given an opportunity to demonstrate that the contractor has instituted all the specific affirmative action steps specified and has made every good faith effort to make these steps work toward the attainment of its goals within the timetables, all to the purpose of expanding minority and female utilization in its aggregate workforce. A contractor, who fails to comply with its obligation under the Equal Opportunity Clause of its contract and fails to achieve its commitments to the goals for minority and female utilization has the burden of proving that it has engaged in an Affirmative Action Program directed at increasing minority and female utilization and that such efforts were at least as extensive and as specific as the following:

- a. The contractor should have notified minority and female organizations when employment opportunities were available and should have maintained records of the organization's response.
- b. The contractor should have maintained a file of the names and addresses of each minority and female referred to it by any individual or organization and what action was taken with respect to each such referred individual, and if the individual was not employed by the contractor, the reasons. If such individual was sent to the union hiring hall for referral and not referred back by the union or if referred, not employed by the contractor, the file should have documented this and their reasons.
- c. The contractor should have promptly notified the Department of Public Works, and Mayor's Office of Contract Compliance when the union or unions with which the contractor has collective bargaining agreements did not refer to the contractor a minority or female sent by the contractor, or when the contractor has other information that the union referral process has impeded efforts to meet its goals.
- d. The contractor should have disseminated its EEO policy within its organization by including it in any employee handbook or policy manual; by publicizing it in company newspapers and annual reports and by advertising such policy at reasonable intervals in union publications. The EEO policy should be further disseminated by conducting staff meetings to explain and discuss the policy; by posting of the policy; and by review of the policy with minority and female employees.
- e. The contractor should have disseminated its EEO policy externally by informing and discussing it with all recruitment sources; by advertising in news media, specifically including minority and female news media; and by notifying and discussing it with all subcontractors.
- f. The contractor should have made both specific and reasonably recurrent written and oral recruitment efforts. Such efforts should have been directed at minority and female organizations, schools with substantial minority and female enrollment, and minority and female recruitment and training organizations within the contractor's recruitment area.

- g. The contractor should have evidence available for inspection that all tests and other selection techniques used to select from among candidates for hire, transfer, promotion, training, or retention are being used in a manner that does not violate the OFCCP Testing Guidelines in 41 CFR Part 60-3.
- h. The contractor should have made sure that seniority practices and job classifications do not have a discriminatory effect.
- i. The contractor should have made certain that all facilities are not segregated by race.
- j. The contractor should have continually monitored all personnel activities to ensure that its EEO policy was being carried out including the evaluation of minority and female employees for promotional opportunities on a quarterly basis and the encouragement of such employees to seek those opportunities.
- k. The contractor should have solicited bids for subcontracts from available minority and female subcontractors engaged in the trades covered by these Bid conditions, including circulation of minority and female contractor associations.

**NOTE:** The Director and the Mayor's Office of Contract Compliance will provide technical assistance on questions pertaining to minority and female recruitment sources, minority and female community organizations, and minority and female news media upon receipt of a request for assistance from a contractor.

**3. NON-DISCRIMINATION:**

In no event may a contractor utilize the goals and affirmative action steps required in such a manner as to cause or result in discrimination against any person on account of race, color, religion, sex, marital status, national origin, age, mental or physical handicap, political opinion or affiliation.

**4. COMPLIANCE AND ENFORCEMENT:**

In all cases, the compliance of a contractor will be determined in accordance with its obligations under the terms of these Bid Conditions. All contractors performing or to perform work on projects subject to these Bid Conditions hereby agree to inform their subcontractors in writing of their respective obligations under the terms and requirements of these Bid Conditions, including the provisions relating to goals of minority and female employment and training.

**A. Contractors Subject to these Bid Conditions:**

In regard to these Bid Conditions, if the contractor meets the goals set forth therein or can demonstrate that it has made every good faith effort to meet these goals, the contractor shall be presumed to be in compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, the implementing regulations and its obligations under these Bid Conditions. In the event, no formal sanctions or proceedings leading toward sanctions shall be instituted unless the contracting or administering agency otherwise determines that the contractor is violating the Equal Opportunity Clause.

- 1. Where the Office of Contract Compliance finds that a contractor failed to comply with the requirements of Article 111, Division 2, Chapter 28 of the Revised Municipal

Code or the implementing regulations and the obligations under these Bid Conditions, and so informs the Manager, the Manager shall take such action and impose such sanctions, which include suspension, termination, cancellation, and debarment, as may be appropriate under the Ordinance and its regulations. When the Manager proceeds with such formal action it has the burden of proving that the contractor has not met the goals contained in these Bid Conditions. The contractor's failure to meet its goals shall shift to it the requirement to come forward with evidence to show that it has met the good faith requirements of these Bid Conditions.

2. The pendency of such proceedings shall be taken into consideration by the Department of Public Works in determining whether such contractor can comply with the requirements of Article 111, Division 2, Chapter 28 of the Revised Municipal Code, and is therefore a "responsible prospective contractor".
3. The Mayor's Office of Contract Compliance shall review the contractor's employment practices during the performance of the contract. If the Mayor's Office of Contract Compliance determines that the contractor's Affirmative Action Plan is no longer an acceptable program, the Director shall notify the Manager.

B. **Obligations Applicable to Contractors:**

It shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority or female employees. Discrimination in referral for employment, even if pursuant to provisions of a collective bargaining agreement, is prohibited by the National Labor Relations Act, as amended, Title VI of the Civil Rights Act of 1964, as amended, and Article III, Division 2, Chapter 28 of the Revised Municipal Code. It is the policy of the Department of Public Works that contractors have a responsibility to provide equal employment opportunity, if they wish to participate in City and County of Denver contracts. To the extent they have delegated the responsibility for some of their employment practices to a labor organization and, as a result, are prevented from meeting their obligations pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, such Contractors cannot be considered to be in compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, or its implementing rules and regulations.

C. **General Requirements**

Contractors are responsible for informing their subcontractors in writing regardless of tier, as to their respective obligations. Whenever a contractor subcontracts a portion of work in any trade covered by these Bid Conditions, it shall include these Bid Conditions in such subcontracts and each subcontractor shall be bound by these Bid Conditions to the full extent as if it were the prime contractor. The contractor shall not, however, be held accountable for the failure of its subcontractors to fulfill their obligations under these Bid Conditions. However, the prime contractor shall give notice to the Director of any refusal or failure of any subcontractor to fulfill the obligations under these Bid Conditions. A subcontractor's failure to comply will be treated in the same manner as such failure by a prime contractor.

1. Contractors hereby agree to refrain from entering into any contract or contract modification subject to Article 111, Division 2, Chapter 28 of the Revised Municipal Code with a contractor debarred from, or who is determined not to be a "responsive" bidder for the City and County of Denver contracts pursuant to the Ordinance.
2. The contractor shall carry out such sanctions and penalties for violation of these Bid Conditions and the Equal Opportunity Clause including suspension, termination and cancellation of existing subcontracts and debarment from future contracts as may be ordered by the Manager pursuant to Article 111, Division 2, Chapter 28 of the Revised Municipal Code and its implementing regulations.
3. Nothing herein is intended to relieve any contractor during the term of its contract from compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the Equal Opportunity Clause of its contract with respect to matters not covered in these Bid Conditions.
4. Contractors must keep such records and file such reports relating to the provisions of these Bid Conditions as shall be required by the Office of Contract Compliance.
5. Requests for exemptions from these Bid Conditions must be made in writing, with justification, to the Manager of Public Works, City and County Building, Room 379, Denver, Colorado 80202, and shall be forwarded through and with the endorsement of the Director.

**EXHIBIT C**

**CITY AND COUNTY OF DENVER  
INSURANCE REQUIREMENTS FOR DEPARTMENT OF AVIATION  
OWNER CONTROLLED INSURANCE PROGRAM (OCIP/ROCIP) PROJECT**

**NOTICE OF CHANGE TO ROCIP:** DEN reserves the right to terminate or modify the DEN ROCIP or any portion thereof. Further, dependent on factors including, but not limited to, the official timing and duration of the ROCIP project for which services are provided under this Agreement, DEN may need to transition from one ROCIP program to another and introduce corresponding requirements for contractors. DEN will provide Contractor notice in accordance with the terms and conditions of this Agreement.

**1. General Information**

City and County of Denver and Denver International Airport (hereinafter referred to collectively as “DEN”) has arranged for certain construction activities at DEN to be insured under an Owner Controlled Insurance Program (OCIP) or a Rolling Owner Controlled Insurance Program (ROCIP) (hereinafter collectively referred to as “ROCIP”). A ROCIP is a single insurance program that insures DEN, the Contractor and subcontractors of any tier, and other designated parties (Enrolled Parties), for work performed at the Project Site. Certain trade contractors and subcontractors are ineligible for this program; see ROCIP Insurance Manual Section 4. Insurance requirements are determined based on the scope of work.

## 1.2 ROCIP Manuals

Below are links to access the current reference manuals related to DEN ROCIP. These manuals are part of the Contract Documents.

[ROCIP Insurance Manual](#)

[ROCIP Safety Manual](#)

[ROCIP Claims Guide](#)

**2. Insurance Requirements for Non-ROCIP Contractors and Subcontractors (Ineligible Parties)**

Contractor and subcontractors of any tier shall require all Ineligible Parties, as defined in ROCIP Insurance Manual Section 4 or confirmed as excluded by DEN, to provide and maintain insurance of the type and in limits as set forth in the Contractor Subcontract Agreement and such insurance shall include the minimum defined coverages and be evidenced to DEN as required in this Section 2.

## 2.1 Certificate Holder

Certificate(s) shall be issued to:	CITY AND COUNTY OF DENVER Denver International Airport 8500 Peña Boulevard, Suite 8810 Denver CO 80249 Attn: Risk Management
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## 2.2 Acceptable Certificate of Insurance Form and Submission Instructions

**Please read these requirements carefully to ensure proper documentation and receipt of your certificate(s) of insurance.**

- ACORD FORM (or equivalent) certificate is required.
- SUBMIT via emailed in pdf format to: [contractadmininvoices@flydenver.com](mailto:contractadmininvoices@flydenver.com)
- ELECTRONIC CERTIFICATES are required, hard copy documents will not be accepted.

- THIRD PARTY SOFTWARE may be implemented during the term of this Agreement to manage insurance compliance and documents with required use by Vendor of such system.
- REFERENCE on the certificate must include the DEN assigned Contract Number.

## 2.3 Coverage and Limits

### 2.3.1 Commercial General Liability

Contractor shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, independent contractors, and products and completed operations in minimum limits of \$1,000,000 each occurrence, \$2,000,000 products and completed operations aggregate; if policy contains a general aggregate, a minimum limit of \$2,000,000 annual aggregate must be maintained.

- 2.3.1.1 Coverage shall include Contractual Liability covering liability assumed under this Agreement (including defense costs assumed under contract) within the scope of coverages provided.
- 2.3.1.2 Coverage shall include Mobile Equipment Liability, if used to perform services under this Agreement.

### 2.3.2 Business Automobile Liability

Contractor shall maintain a minimum limit of \$1,000,000 combined single limit each occurrence for bodily injury and property damage for all owned, leased, hired and/or non-owned vehicles used in performing services under this Agreement.

- 2.3.2.1 If operating vehicles unescorted airside at DEN, a \$10,000,000 combined single limit each occurrence for bodily injury and property damage is required.
- 2.3.2.2 If Contractor does not have blanket coverage on all owned and operated vehicles and will require unescorted airside driving privileges, then a schedule of insured vehicles (including year, make, model and VIN number) must be submitted with the Certificate of Insurance.
- 2.3.2.3 If transporting waste, hazardous material, or regulated substances, Contractor shall carry a Broadened Pollution Endorsement and an MCS 90 endorsement on its policy.
- 2.3.2.4 If Contractor does not own any fleet vehicles and Contractor's owners, officers, directors, and/or employees use their personal vehicles to perform services under this Agreement, Contractor shall ensure that one or both of the following coverages are maintained as appropriate: (i) Personal Automobile Liability including a Business Use Endorsement by the vehicle owner and (ii) Non-Owned Auto Liability by the Contractor.
- 2.3.2.5 If Contractor will be completing all services to DEN under this Agreement remotely and not be driving to locations under direction of the City to perform services, this requirement is waived.

### 2.3.3 Workers' Compensation and Employer's Liability Insurance

Contractor shall maintain the coverage as required by statute for each work location and shall maintain Employer's Liability insurance with limits no less than \$1,000,000 per occurrence for each bodily injury claim, \$1,000,000 per occurrence for each bodily injury caused by disease claim, and \$1,000,000 aggregate for all bodily injuries caused by disease claims.

2.3.3.1 Colorado Workers' Compensation Act allows for certain, limited exemptions from Worker's Compensation insurance coverage requirements. It is the sole responsibility of the Contractor to determine their eligibility for providing this coverage, executing all required documentation with the State of Colorado, and obtaining all necessary approvals. Verification document(s) evidencing exemption status must be submitted with the Certificate of Insurance.

#### 2.3.4 Professional Liability (Errors and Omissions) Insurance

Contractor shall maintain a minimum limit of \$1,000,000 each claim and policy aggregate, providing coverage for applicable services outlined in this Agreement. If there are no applicable professional services, this coverage will not be required.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

#### 2.3.5 Contractor's Pollution Legal Liability

If required by DEN Risk Management for any specific Excluded Party based on their scope of work, Contractor shall maintain coverage for its work site operations that are conducted on DEN's premises including project management and site supervision duties with a limit no less than \$1,000,000 each occurrence and aggregate resulting from claims arising out of a pollution condition or site environmental condition resulting out of work site operations on DEN's premises.

2.3.5.1 Coverage shall include claims/losses for bodily injury, property damage including loss of use of damaged property, defense costs including costs and expenses incurred in the investigation, defense or settlement of claims, and cleanup cost for pollution conditions resulting from illicit abandonment, the discharge, dispersal, release, escape, migration or seepage of any solid, liquid, gaseous or thermal irritant, contaminant, or pollutant, including soil, silt, sedimentation, smoke, soot, vapors, fumes, acids, alkalis, chemicals, electromagnetic fields, hazardous substances, hazardous materials, waste materials, low level radioactive waste, mixed wastes, on, in, into, or upon land and structures thereupon, the atmosphere, surface water or groundwater on the DEN premises.

2.3.5.2 Work site means a location where covered operations are being performed, including real property rented or leased from DEN for the purpose of conducting Contractor's covered operations.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

#### 2.3.6 Cyber Liability

If required by DEN Risk Management for any specific Excluded Party based on their scope of work, Contractor shall maintain a minimum limit of \$1,000,000 per occurrence and \$1,000,000 annual policy aggregate covering claims involving privacy violations, information theft, damage to or destruction of electronic information, intentional and/or unintentional release of private information, alteration of electronic information, extortion, and network security.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

2.3.7 Technology Errors and Omissions, Network Security, and Privacy Liability (Cyber):  
If required by DEN Risk Management for any specific Excluded Party based on their scope of work, Contractor shall maintain a limit no less than \$1,000,000 each claim and aggregate; \$1,000,000 each claim and aggregate for cyber extortion; and no less than \$250,000 each claim for invoice manipulation and email spoofing.

2.3.7.1 Coverage shall include, but not be limited to, liability arising from theft, dissemination and/or use of personal, private, confidential, information subject to a non-disclosure agreement, including information stored or transmitted, privacy or cyber laws, damage to or destruction of information, intentional and/or unintentional release of private information, alteration of information, extortion and network security, introduction of a computer virus into, or otherwise causing damage to, a customer's or third person's computer, computer system, network or similar computer related property and the data, software, and programs thereon, advertising injury, personal injury (including invasion of privacy) and intellectual property offenses related to internet.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

2.3.8 Unmanned Aerial Vehicle (UAV) Liability

If Contractor desires to use drones in any aspect of its work on DEN premises, the following requirements must be met prior to commencing any drone operations:

- 2.3.8.1 Express written permission must be granted by DEN.
- 2.3.8.2 Express written permission must be granted by the Federal Aviation Administration (FAA).
- 2.3.8.3 Drone equipment must be properly registered with the FAA.
- 2.3.8.4 Drone operator(s) must be properly licensed by the FAA.
- 2.3.8.5 Contractor must maintain UAV Liability including flight coverage, personal and advertising injury liability, and hired/non-owned UAV liability for its commercial drone operations with a limit no less than \$1,000,000 combined single limit each occurrence for bodily injury and property damage.

2.3.9 Excess/Umbrella Liability

Combination of primary and excess coverage may be used to achieve minimum required coverage limits. Excess/Umbrella policy(ies) must follow form of the primary policies with which they are related to provide the minimum limits and be verified as such on any submitted Certificate of Insurance.

2.4 Reference to Project and/or Contract

The DEN Project and/or Contract Number and project description shall be noted on the Certificate of Insurance.

2.5 Additional Insured

For all coverages required under this Agreement (excluding Workers' Compensation and Professional Liability, if required), Contractor's insurer(s) shall include the City and County of Denver, its elected and appointed officials, successors, agents, employees and volunteers as Additional Insureds by policy endorsement.

## 2.6 Waiver of Subrogation

For all coverages required under this Agreement (excluding Professional Liability, if required), Contractor's insurer(s) shall waive subrogation rights against the City and County of Denver, its elected and appointed officials, successors, agents, employees and volunteers by policy endorsement.

If Contractor will be completing all services to the City under this Agreement remotely and not be traveling to locations under direction of the City to perform services, this requirement is waived specific to Workers' Compensation coverage.

## 2.7 Notice of Material Change, Cancellation or Nonrenewal

Each certificate and related policy shall contain a valid provision requiring notification to the Certificate Holder in the event any of the required policies be canceled or non-renewed or reduction in required coverage before the expiration date thereof.

- 2.7.1 Such notice shall reference the DEN assigned contract number related to this Agreement.
- 2.7.2 Said notice shall be sent thirty (30) days prior to such cancellation, non-renewal or reduction in coverage unless due to non-payment of premiums for which notice shall be sent ten (10) days prior.
- 2.7.3 If such written notice is unavailable from the insurer or afforded as outlined above, Contractor and/or its insurance broker/agent shall provide written notice of cancellation, non-renewal and any reduction in coverage to the Certificate Holder within seven (7) business days of receiving such notice by its insurer(s) and include documentation of the formal notice received from its insurer(s) as verification. Contractor shall replace cancelled or nonrenewed policies with no lapse in coverage and provide an updated Certificate of Insurance to DEN.
- 2.7.4 In the event any general aggregate or other aggregate limits are reduced below the required minimum per occurrence limits, Contractor will procure, at its own expense, coverage at the requirement minimum per occurrence limits. If Contractor cannot replenish coverage within ten (10) calendar days, it must notify the City immediately.

## 2.8 Cooperation

Contractor agrees to fully cooperate in connection with any investigation or inquiry and accept any formally tendered claim related to this Agreement, whether received from the City or its representative. Contractor's failure to fully cooperate may, as determined in the City's sole discretion, provide cause for default under the Agreement. The City understands acceptance of a tendered claim does not constitute acceptance of liability.

## 2.9 Additional Provisions

- 2.9.1 Deductibles or any type of retention are the sole responsibility of the Contractor.
- 2.9.2 Defense costs shall be in addition to the limits of liability. If this provision is unavailable that limitation must be evidenced on the Certificate of Insurance.
- 2.9.3 Coverage required may not contain an exclusion related to operations on airport premises.
- 2.9.4 A severability of interests or separation of insureds provision (no insured vs. insured exclusion) is included under any policy requiring Additional Insured status.
- 2.9.5 A provision that coverage is primary and non-contributory with other coverage or self-insurance maintained by DEN, excluding Professional Liability and Workers' Compensation policies, if required.

- 2.9.6 The insurance requirements under this Agreement shall be the greater of (i) the minimum limits and coverage specified hereunder or (ii) the broader coverage and maximum limits of coverage of any insurance policy or proceeds available to the Contractor. It is agreed that the insurance requirements set forth herein shall not in any way act to reduce coverage that is broader or that includes higher limits than the minimums set forth in this Agreement.
- 2.9.7 All policies shall be written on an occurrence form when available and industry norm. If an occurrence form is unavailable and/or the industry norm, claims-made coverage may be accepted by DEN provided the retroactive date is on or before the Agreement Effective Date or the first date when any goods or services were provided to DEN, whichever is earlier, and continuous coverage will be maintained or an extended discovery period of three years beginning at the time work under this Agreement is completed or the Agreement is terminated, whichever is later.
- 2.9.8 Certificates of Insurance must specify the issuing companies, policy numbers and policy periods for each required form of coverage. The certificates for each insurance policy are to be signed by an authorized representative and must be submitted to the City at the time Contractor signed this Agreement.
- 2.9.9 The insurance shall be underwritten by an insurer licensed or authorized to do business in the State of Colorado and rated by A.M. Best Company as A- VIII or better.
- 2.9.10 Certificate of Insurance and Related Endorsements: The City's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements shall not act as a waiver of Contractor's breach of this Agreement or of any of the City's rights or remedies under this Agreement. All coverage requirements shall be enforced unless waived or otherwise modified in writing by DEN Risk Management. Contractor is solely responsible for ensuring all formal policy endorsements are issued by their insurers to support the requirements.
- 2.9.11 The City shall have the right to verify, at any time, all coverage, information, or representations, and the insured and its insurance representatives shall promptly and fully cooperate in any such audit the City may elect to undertake including provision of copies of insurance policies upon request. In the case of such audit, the City may be subject to a non-disclosure agreement and/or redactions of policy information unrelated to the required coverage and premium amounts.
- 2.9.12 No material changes, modifications, or interlineations to required insurance coverage shall be allowed without the review and written approval of DEN Risk Management.
- 2.9.13 Contractor shall be responsible for ensuring the City is provided updated Certificate(s) of prior to each policy renewal.
- 2.9.14 Contractor's failure to maintain required insurance shall be the basis for immediate suspension and cause for termination of this Agreement, at the City's sole discretion and without penalty to the City.

2.10 Part 230 and the DEN Airport Rules and Regulations

If the minimum insurance requirements set forth herein differ from the equivalent types of insurance requirements in Part 230 of the DEN Airport Rules and Regulations, the greater and broader insurance requirements shall supersede those lesser requirements, unless expressly excepted in writing by DEN Risk Management.

**3. Insurance Requirements for ROCIP Enrolled Contractors and Subcontractors**

3.1 Insurance Provided by the DEN ROCIP

DEN retains the right to have this Project insured under a ROCIP. ROCIP coverage shall provide: (i) Commercial General Liability, (ii) Workers' Compensation & Employer's Liability, (iii) Excess Liability, (iv) Contractor's Pollution Liability, and (v) Builder's Risk as outlined herein and as defined by the respective policies for each coverage, for the period from the start of Work through completion and final acceptance by DEN except as otherwise provided herein.

### 3.2 Enrollment Required

Parties performing labor or services at the Project Site are eligible to enroll in the DEN ROCIP, unless they are Ineligible Parties (as defined in ROCIP Insurance Manual Section 4). Participation is mandatory but not automatic. Parties eligible for enrollment shall follow the procedures and follow the instructions as provided in the DEN ROCIP Insurance Manual to enroll in the program. When the Contractor and subcontractors of any tier are properly enrolled, the DEN ROCIP Administrator will issue a Certificate of Insurance evidencing the coverages afforded to each Enrolled Party under the DEN ROCIP, prior to their commencing Work on the Project Site.

### 3.3 Exclusion of Contractor/Subcontractor Insurance Costs from Proposal and Bid Prices

Contractor shall exclude from Contractor's cost of work and ensure that each subcontractor of any tier exclude from their cost of work, normal costs for insurance for those coverages provided under the DEN ROCIP. As part of the enrollment process, Contractor and subcontractors shall provide policy declaration rate pages and deductible endorsements on the General Liability, Workers' Compensation, and Excess Liability policies as required in the DEN ROCIP Insurance Manual. The calculation of these costs will be determined by the ROCIP Program Administrator. The costs of DEN ROCIP coverage includes reductions in insurance premiums, all relevant taxes and assessments, markup on insurance premiums, and losses retained through large deductibles, self-insured retentions, or self-funded programs. Change orders shall also exclude the cost of ROCIP coverage.

Pre-employment substance abuse testing costs will be covered by DEN and should be removed from bid prices. Drug testing will be more thoroughly discussed in the ROCIP Safety Manual.

### 3.4 Insurance Premiums

DEN will pay the insurance premiums for the DEN ROCIP insurance policies. DEN is responsible for all adjustments to the premiums and will be the sole beneficiary of all dividends, retroactive adjustments, return premiums, and any other monies due through audits or otherwise. The Contractor assigns to DEN the right to receive all such adjustments and will require that each subcontractor of any tier assign to DEN all such adjustments. The Contractor and the subcontractors who are Enrolled Parties shall execute such further documentation as may be required by DEN to accomplish this assignment.

### 3.5 Off Site Operations Coverage Under ROCIP

The DEN ROCIP will provide certain insurance coverage for DEN, Contractor and Enrolled Parties, along with their Eligible Employees performing Work at the Project Site. Off-site operations shall be covered only if designated in writing by DEN and when all operations at such site are identified and solely dedicated to the Project. Contractors and subcontractors are responsible to notify the DEN ROCIP Administrator in writing, to request coverage for specified off-site operations. Coverage is not provided at the off-site location unless confirmed in writing by the DEN ROCIP Administrator.

### 3.6 DEN ROCIP Insurance Manual

As soon as practicable, the DEN ROCIP Insurance Manual will be sent to each Enrolled Party and will become a part of the Contract and Contractor's Subcontract with its subcontractor and its subcontractors' agreements with any lower-tier subcontractor. The DEN ROCIP Insurance Manual will contain the administrative and claim reporting procedures. Contractor agrees to and will require that its subcontractors of any tier to cooperate with the DEN ROCIP Administrator in providing all required information.

### 3.7 Conflicts

Descriptions of the DEN ROCIP coverages set forth in ROCIP Insurance Manual Section 4.6 are not intended to be complete or meant to alter or amend any provision of the DEN ROCIP insurance policies. The DEN ROCIP coverages, terms, conditions, and exclusions are set forth in full in their respective policy forms. In the event of a conflict or omission between the coverages provided in the DEN ROCIP insurance policies and the coverages summarized or described in the DEN ROCIP Insurance Manual, this Exhibit or elsewhere in the Contract Documents, the DEN ROCIP insurance policies shall govern. In the event of a conflict between the provisions of this Exhibit and the DEN ROCIP Insurance Manual, that does not involve any conflict with the provisions of the DEN ROCIP insurance policies, the provisions of this Exhibit shall govern.

### 3.8 ROCIP Insurance Coverage Provided to Enrolled Parties

#### 3.8.1 Insurance Provided by DEN

Unless otherwise provided herein, prior to commencement of the Work, DEN, at its sole option and expense, shall secure and maintain at all times during the performance of this Contract the insurance specified below, insuring DEN, Enrolled Parties and such other persons or interests as DEN may designate with limits not less than those specified below for each coverage.

##### 3.8.1.1 Workers' Compensation & Employer's Liability – On Site Only

DEN shall maintain the coverage as required by statute for the Project Site and shall maintain Employer's Liability insurance with limits no less than \$1,000,000 per occurrence for each bodily injury claim, \$1,000,000 per occurrence for each bodily injury caused by disease claim, and \$1,000,000 aggregate for all bodily injuries caused by disease claims.

##### 3.8.1.2 Commercial General Liability – On Site Only

DEN shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, and products and completed operations in minimum limits as listed below:

Coverage	Limit
Annual General Aggregate (Per Project and Reinstates Annually)	\$4,000,000
Products/Completed Operations Aggregate (Per Project and Statute of Repose)	\$4,000,000
Total Products/Completed Operations Aggregate (Statute of Repose)	\$20,000,000
Personal / Advertising Injury Limit	\$2,000,000
Each Occurrence Limit	\$2,000,000
Fire Damage Legal Liability (any one fire)	\$ 300,000
Medical Payments (any one person)	\$ 10,000

##### 3.8.1.3 Excess Liability Insurance

DEN shall maintain coverage following form with underlying policies of Commercial General Liability and Employer's Liability in minimum limits as listed below:

Coverage	Limit
Annual General Aggregate (Per Project and Reinstates Annually)	\$200,000,000
Products/Completed Operations Aggregate (Per Project)	\$20,000,000
Total Products/Completed Operations Aggregate (Policy Cap)	\$400,000,000
Each Occurrence Limit	\$200,000,000

DEN, in its sole discretion, may elect to provide higher limits, based on Project size. Excess Liability limits are shared by all Insured parties.

#### 3.8.1.4 Contractor's Pollution Liability

DEN shall maintain coverage for bodily injury, property damage, or environmental damage caused by a pollution event resulting from covered operations, including completed operations, at the Project Site with a limit no less than \$10,000,000 each occurrence and aggregate. Coverage includes microbial matter and legionella pneumophila in any structure on land and the atmosphere contained with the structure. Products/Completed Operations coverage may extend for the statute of limitations/repose after final completion of the Project.

#### 3.8.1.5 Builder's Risk Insurance

DEN shall maintain, Builder's Risk (and/or Installation Floater) in the amount of \$200,000,000 per occurrence subject to various sublimits (as defined in the Builders' Risk Policy). Such insurance shall end when the first of the following occurs: 1) DEN's interest in the Work ceases; 2) the policy expires or is cancelled; or 3) the Work is accepted by DEN.

Builder's Risk Insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss of damage including , theft, vandalism, malicious mischief, terrorism, rigging and hoisting for materials and equipment that are part of the Project, collapse, earthquake, flood, windstorm, falsework, testing and startup (as provided by the policy), temporary buildings and debris removal including demolition occasioned by enforcement of any applicable ordinance laws, and shall cover reasonable compensation for services and expenses required as a result of such insured loss.

This Builder's Risk Insurance shall cover portions of the Work stored off site, and also portions of the Work in transit.

DEN and Contractor shall waive all rights against (1) each other and any of their subcontractors of any tier, and all respective agents and employees, and (2) the architect, architect's consultants, separate contractors, if any, and any of their subcontractors of any tier, and all respective agents and employees, for damages caused by fire or other causes of loss to the extent covered by Builder's Risk Insurance obtained pursuant to this Section or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by DEN as fiduciary. DEN or Contractor, as appropriate, shall require of the architect, architect's consultants, separate contractors, and their subcontractors of any tier, and all respective agents and employees, by appropriate agreements, written where

legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

3.8.2 Claim Chargeback

A claim charge-back will be assessed, regardless of fault, for the amount of any loss payable under this program with the exception of Workers' Compensation and Excess Liability, up to a maximum of \$25,000 each loss. General Contractor may elect to pass no more than \$5,000 of this charge, each loss, through to any responsible subcontractor.

3.9 Other Insurance Provided By Enrolled Parties

At their own expense, the Enrolled Parties of all tiers must carry the following minimum coverage and limits and such insurance shall be evidenced to DEN and the DEN ROCIP Administrator as required in this Section 3.9.

3.9.1 Certificate Holder

Certificate(s) shall be issued to: CITY AND COUNTY OF DENVER  
Denver International Airport  
8500 Peña Boulevard, Suite 8810  
Denver CO 80249  
Attn: Risk Management

and

CITY AND COUNTY OF DENVER  
Department of Aviation  
c/o Marsh USA, Inc.  
111 SW Columbia, Ste 500  
Portland, OR 97201

3.9.2 Acceptable Certificate of Insurance Form and Submission Instructions

Please read these requirements carefully to ensure proper documentation and receipt of your certificate(s) of insurance.

- ACORD FORM (or equivalent) certificate is required.
- SUBMIT via emailed in pdf format to: contractadmininvoices@flydenver.com and DenverAirport.ROCIP@marsh.com
- ELECTRONIC CERTIFICATES are required, hard copy documents will not be accepted.
- THIRD PARTY SOFTWARE may be implemented during the term of this Agreement to manage insurance compliance and documents with required use by Vendor of such system.
- REFERENCE on the certificate must include the DEN assigned Contract Number.

3.9.3 Other Insurance Requirements

Enrolled Contractors shall adhere to the same minimum insurance requirements as stated in Section 2 of this exhibit, with the following exceptions:

- Commercial General Liability coverage requirement is Off Site Only

- Workers' Compensation and Employer's Liability coverage requirement is Off Site Only
- Contractor's Pollution Legal Liability is not required

#### **4. Contractor Warranties and Agreements**

##### **4.1 Accuracy of Contractor-provided Information**

Contractor warrants that all information submitted to DEN or the DEN ROCIP Administrator is accurate and complete to the best of its knowledge. Contractor will notify DEN or the DEN ROCIP Administrator immediately in writing of any errors discovered during the performance of the Work.

##### **4.2 Contractor Responsible to Review Coverage**

Contractor acknowledges that all references to DEN ROCIP policy terms, conditions, and limits of liability in this document, as well as the DEN ROCIP Insurance Manual, are for reference only. Contractor and its subcontractors of any tier are responsible for conducting their own independent review and analysis of the DEN ROCIP insurance policies in formulating any opinion or belief as to the applicability of such coverage in the event of any loss or potential claim. Any type of insurance or increase of limits not described above, which the Contractor requires for its own protection or on account of statute, shall be its own responsibility and at its own expense.

##### **4.3 Audit**

Contractor agrees to make its records available for review and to cooperate with DEN, its insurers and insurance brokers, the City Auditor, and representatives of the aforesaid parties in the event of an audit. In the event that a DEN audit of Contractor's records, as permitted in the Contract or other DEN ROCIP documents, reveals a discrepancy in the insurance, payroll, safety, or any other information required to be provided to DEN or the DEN ROCIP Administrator, or reveals inclusion of costs for DEN ROCIP coverage or other coverage beyond what is described above in any payment for the Work, DEN will have the right to deduct from payments due Contractor all such insurance costs as well as all audit costs.

##### **4.4 Insurance Costs Removed**

Contractor warrants that the costs for insurance as provided under the DEN ROCIP were not included in Contractor's bid or proposal for the Work, the Contract Price/Contract Sum, and will not be included in any change order or any request for payment for the Work or extra work.

#### **5. Contractor Obligations**

##### **5.1 ROCIP Documents Shall be Provided to Subcontractor**

Contractor shall furnish each bidding subcontractor, vendor, supplier, material dealer or other party a copy of this Exhibit, the DEN ROCIP Insurance Manual and the DEN ROCIP Safety Manual and shall incorporate the terms of this Exhibit in all contracts and agreements entered into for performance of any portion of the Work.

##### **5.2 Timely Enrollment Required**

Contractor shall enroll in the DEN ROCIP within five (5) business days following a request by DEN or the DEN ROCIP Administrator. Contractor shall notify each subcontractor of the process for enrolling in DEN ROCIP and confirm that enrollment is mandatory, but not automatic. Contractor shall assure that subcontractors of any tier shall not commence Work until verification of enrollment is confirmed by the DEN ROCIP Administrator by the issuance of a Certificate of Insurance to each individual Enrolled Party.

### 5.3 Compliance with Conditions

Contractor shall not violate any condition of the policies of insurance provided by DEN under the terms of this Exhibit, the DEN ROCIP Insurance Manual or the DEN ROCIP Safety Manual. All requirements imposed by the subject policies and to be performed by Contractor shall likewise be imposed on, assumed, and performed by each subcontractor of any tier.

### 5.4 Claims Cooperation

Contractor shall participate in claim reporting procedures. Contractor agrees to assist and cooperate in every manner possible in connection with the adjustment of all claims arising out of operations within the scope of the Work required by the Contract, and to cooperate with DEN's insurer(s) in all claims and demands which DEN's insurer(s) is called upon to adjust or to defend against. Contractor shall take all necessary action to assure that its subcontractors of any tier comply with any request for assistance and cooperation. This obligation includes, without limitation, providing light or modified duty for injured workers, appearing in mediation, arbitration, or court proceedings and/or participating in settlement meetings, as may be required.

### 5.5 Monthly Payroll Submission

All Enrolled Parties shall submit monthly payrolls and worker-hour reports to DEN and/or the DEN ROCIP Administrator via the DEN ROCIP Administrator's online reporting system as outlined in the DEN ROCIP Insurance Manual. The online reporting instructions will be provided to all Contractors at time of enrollment. Failure to submit these reports may result in funds being held or delayed from monthly progress payments. Payroll must be submitted online for each month, including zero (0) payroll, if applicable, until completion of the Work under each Contract and Subcontract. For subcontractors of any tier performing Work under multiple Subcontracts, a separate payroll report is required for each Subcontract under which Work is being performed.

### 5.6 Response to Information Requests

All insurance underwriting, payroll, rating or loss history information requested by DEN or the DEN ROCIP Administrator shall be provided by the Contractor within three (3) business days of request. Contractor agrees (and will require each subcontractor to agree) that DEN, DEN's insurers or its representative may audit the Contractor's records or records of subcontractors of any tier to confirm the accuracy of all insurance information provided including, without limitation, any such information that may have any effect on insurance resulting from changes in the Work. At all times during performance of the Contract and Subcontracts, the Contractor and subcontractors of any tier shall cooperate with DEN, the DEN ROCIP Administrator and DEN's insurers.

### 5.7 Responsibility for Safety

Notwithstanding the DEN ROCIP, the Contractor shall initiate, maintain, and supervise all safety precautions and programs in connection with the Work. Contractor is solely responsible, at no adjustment to the contract sum payable or contract time, for initiating, maintaining, and supervising all safety precautions and programs relating to the conduct of Work including, without limitation, any safety programs or procedures that are required by any applicable state or federal laws, rules or regulations, or under the terms of the DEN ROCIP Safety Manual.

### 5.8 Duty of Care

Nothing herein shall relieve the Enrolled Parties of their respective obligations to exercise due care in the performance of their duties in connection with the Work or to complete the Work in strict compliance with this Contract and subsequent subcontracts.

## 6. Notices and Costs

### 6.1 Limitations on DEN Provided Coverage and DEN Right to Purchase Other Coverage

DEN assumes no obligations to provide insurance other than that evidenced by the policies referred to in Section 3.8. DEN, however, reserves the right to furnish insurance coverage of various types and limits provided that such coverage shall not be less than that specified in Section 3.8 and the costs of such insurance shall be paid by DEN. Apart from the DEN ROCIP, DEN may at its option purchase additional insurance coverages that insure the Project that may not necessarily insure the Contractor or the subcontractors. Without limitation, examples of such coverage may include pollution liability, excess professional liability, and excess automobile liability insurance.

### 6.2 Contractors Responsible for Own Equipment

Contractor and subcontractors are solely responsible for loss or damage of all construction tools and other equipment whether owned, leased, rented, borrowed, or used on Work at the Project Site. If an individual Enrolled Party purchases insurance on their tools and equipment, such insurance shall contain a waiver of subrogation in favor of the City and County of Denver, its elected and appointed officials, agents, employees and volunteers and all other Enrolled Parties. If an individual Enrolled Party does not purchase such insurance, that Enrolled Party will hold harmless the City and County of Denver, its elected and appointed officials, agents, employees and volunteers and other Enrolled Parties for loss or damage to its tools and equipment.

### 6.3 No Release; No Waiver of Immunity

The provision of the DEN ROCIP shall in no way be interpreted as relieving Contractor or subcontractors of any tier of any responsibility or liability under the Contract Documents, the DEN ROCIP insurance policies or applicable laws including, without limitation, Contractor's and subcontractor's responsibilities relative to indemnification and their obligation to exercise due care in the performance of the Work and to complete the Work in strict compliance with the Contract Documents. The parties hereto understand and agree that the City and County of Denver, its elected and appointed officials, agents, employees and volunteers are relying on, and do not waive or intend to waive by any provisions of this agreement, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, §§ 24-10-101 to 120, C.R.S., or otherwise available to DEN, its officers, officials and employees.

### 6.4 DEN Right to Withhold Payments

In addition to any other rights of withholding that DEN may have under the Contract Documents, DEN has the right to withhold any payments otherwise due to Contractor in the event of a failure by Contractor or any subcontractor to comply with the requirements of this Exhibit, the DEN ROCIP Insurance Manual or the DEN ROCIP Safety Manual. DEN may withhold from any payment owing to Contractor the costs of DEN ROCIP coverages if included in a request for payment. Such withholding by DEN shall not be deemed to be a default under the Contract. DEN shall withhold from Contractor the costs of DEN ROCIP coverages attributable to an increase in an Enrolled Party's total payroll for the Work over the amount reported to DEN and/or the DEN ROCIP Administrator at time of enrollment.

### 6.5 DEN Remedies

Without limitation upon any of DEN's other rights or remedies, any failure of an Enrolled Party to comply with any provision of this Exhibit, the DEN ROCIP Insurance Manual, or the DEN ROCIP Safety Manual shall be deemed a material breach of the Contract, thereby entitling DEN, at its option, upon notice to Contractor, to (1) suspend performance by Contractor and/or the offending subcontractor, without any adjustment to Contract Sum Payable or Contract Time, until there is full compliance, or (2) terminate this Contract for cause.

## 6.6 Off Site Storage

Unless otherwise provided in the Contract Documents, the property insurance provided by DEN shall not cover portions of the Work stored off the Site without written approval of DEN. Contractor shall be responsible for reporting such property or work if ownership has been transferred to DEN. If ownership rests with the Contractor, Contractor shall be responsible for obtaining insurance to protect its interests.

## 6.7 Partial Occupancy

Partial occupancy or use shall not commence until DEN insurer(s) providing Builders Risk and/or Property Insurance have consented to such partial occupancy or use by endorsement or otherwise. DEN and the Contractor shall take reasonable steps to obtain consent of the insurer(s) and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

## 6.8 DEN Right to Exclude Parties from the DEN ROCIP

DEN reserves the right to exclude any subcontractor from the DEN ROCIP, before or after enrollment by the subcontractor. If DEN elects to exclude a subcontractor from the DEN ROCIP, the Contractor will be responsible for ensuring the insurance coverages outlined in the Contractor's Subcontract Agreement are provided to DEN or the DEN ROCIP Administrator before the subcontractor can begin or resume Work on the Project.

## 6.9 DEN's Right to Modify or Discontinue DEN ROCIP Coverages

If DEN determines that modification or discontinuation of the DEN ROCIP is in the best interest of DEN, the Contractor and subcontractor will receive sixty (60) days advance written notice to secure and maintain such insurance as is required to provide replacement coverage comparable to that provided under the DEN ROCIP. Provided that the foregoing is not the result of any failure by the Contractor or any subcontractor to comply with the requirements of the Contract Documents, the DEN ROCIP Insurance Manual or DEN ROCIP Safety Manual, the costs of such replacement insurance shall be deemed a cost of Work for which the Contractor shall be entitled to a Contract Adjustment, without any sum added thereto for Allowable Markup. The form, content, limits of liability, cost and the rating of the insurer(s) issuing such replacement coverage shall be subject to DEN's prior written approval.

## 7. Definitions

Certificate of Insurance:	A document providing evidence of coverage for a particular insurance policy or policies. This will include certificates issued to Enrolled Parties evidencing the coverage afforded under the DEN ROCIP and certificates issued to DEN evidencing additional coverage "Provided by Enrolled Parties"
DEN:	City and County of Denver and Denver International Airport
Contract:	The written agreement between DEN and Contractor describing the Work, contract terms and conditions, or a portion thereof; also includes a written agreement between a Contractor and any subcontractor as well as between subcontractors and their subcontractors of any tier.
Contractor Insurance Cost:	The costs of ROCIP coverage are defined as the amount of Contractor's and eligible Subcontractors' of every tier reduction in insurance costs due to participation in the DEN ROCIP.

Rolling Owner Controlled Insurance Program (ROCIP): A coordinated insurance program providing certain coverage, as defined herein, for DEN, Contractor and Enrolled Subcontractors, along with their Eligible Employees, performing Work at the Project Site.

Eligible Employees: Employees of the Contractor and Enrolled Subcontractors who are not excluded from the ROCIP under the “Excluded Parties” definition.

Enrolled Parties: The Contractor and those subcontractors that have submitted all necessary enrollment information and been accepted into the ROCIP as evidenced by the issuance of a Certificate of Insurance.

Ineligible/Excluded Parties: Parties not covered by the ROCIP because of ineligibility or DEN explicit exclusion. No insurance coverage provided by DEN under the ROCIP shall extend to the activities or products of the following:

- Any person or organization that fabricates or manufactures products, materials or supplies away from a Project Site with no direct onsite installation responsibility

Exception: The ROCIP Insurer may agree to extend General Liability coverage only if the General Contractor has a written contract with the off-site fabricator or manufacturer to provide the pre-fabricated product. To consider extending coverage, the Insurer requires 30 days advance written notice to the ROCIP Administrator with details of the work/product and a copy of the contract between the General Contractor and the off-site fabricator or manufacturer. Approval must be obtained from the Insurer before enrolling in the ROCIP for General Liability coverage only.

- Scaffolding contractors (erecting and dismantling scopes of work only)
- Hazardous materials remediation, removal, or transportation companies and their consultants
- Architects, engineers, surveyors and their consultants
- Truckers, haulers, material dealers, vendors, suppliers, and others who merely transport, pick up, deliver, or carry materials, personnel, parts or equipment or any other items or persons to or from a Project Site including companies providing supplemental services
- Contractors, subcontractors and subconsultants who do not work at a Project Site
- Employees of an Enrolled Party who either (i) do not work on-site or (ii) occasionally visit a Project Site to make deliveries, pick-up supplies or personnel, to perform supervisory or progress inspections, or for any other reason

- Temporary labor employees (individuals working directly for the Contractor and not procured through a third party such as a Professional Employer Organization)

Exception: The ROCIP Insurer typically will accept including employees working for a contractor, or employed by temporary staffing agencies or professional employer organizations, as long as those employer-entities are enrolled as subcontractors to supply supplemental workforce.

Insured: (liability policies)	DEN, Contractor and Enrolled Parties and their Eligible Employees and any other party named in the insurance policies.
Insurers:	Those insurance companies providing the DEN ROCIP coverage. The insurers will be identified on the issued Certificate of Insurance and in the DEN ROCIP Insurance Manual.
Net Bid:	Contractor bids with insurance costs removed because of the obligation of any Enrolled Party to delete insurance costs for coverage provided by the ROCIP from its bid and all change orders. Net bids are subject to verification by the Administrator through the providing of contractors' rate and declaration pages from their Insurance policies.
ROCIP Administrator:	The DEN ROCIP Administrator will be identified in the DEN ROCIP Insurance Manual.
ROCIP Insurance Manual:	A reference document provided to Contractor and subcontractors of all tiers, which summarizes the terms and provisions of the DEN ROCIP and provides information about requirements and compliance.
ROCIP Safety Manual:	A reference document provided to Contractor and subcontractors of all tiers which contains workplace safety requirements of all Enrolled Parties.
Off Site Work:	Work performed away from the Project Site.
Payroll:	For purposes of the ROCIP only, refers to Unburdened Straight Time Payroll per Workers Compensation Class Code.
Policy Owner:	City and County of Denver and Denver International Airport
Project:	The Project as defined in the contract documents and as described in the Declarations of the DEN ROCIP insurance policies.

**Project Site:** Means those areas designated in writing by DEN in a Contract document for performance of the Work and such additional areas as may be designated in writing by DEN for Contractors' use in performance of the Work. Subject to the ROCIP Insurer(s) written approval, the term "Project Site" shall also include: (1) field office sites, (2) property used for bonded storage of material for the Project approved by DEN, staging areas dedicated to the Project, and (4) areas where activities incidental to the Project are being performed by Contractor or subcontractors covered by the DEN ROCIP Worker's Compensation policy (if included), but excluding any permanent locations of any Enrolled Party.

*Items 1 through 4 above must be approved by the ROCIP Insurer and listed on the DEN ROCIP insurance policies.*

**Subcontract:** The written agreement between Contractor and subcontractor, or between subcontractor and a lower tier subcontractor, describing the Work, subcontract terms and conditions, or a portion thereof.

**Subcontractor:** Includes those persons, firms, joint venture entities, corporations, or other parties that enter into a Subcontract with Contractor to perform Work at the Project Site and any of these subcontractor's lower-tier subcontractors.

**Work:** Operations, as fully described in the Contract and Subcontract, performed at the Project Site.



**TO:** All Users of the City and County of Denver Prevailing Wage Schedules  
**FROM:** Alex Marvin, Classification and Compensation Analyst Staff  
**DATE:** January 20, 2023  
**SUBJECT:** Latest Change to Prevailing Wage Schedules

The effective date for this publication will be **Friday, January 6, 2023**, and applies to the City and County of Denver for **HIGHWAY CONSTRUCTION PROJECTS** in accordance with the Denver Revised Municipal Code, Section 20-76(c).

General Wage Decision No. CO20230009  
Superseded General Decision No. CO20220009  
Modification No. 0  
Publication Date: 01/06/2023  
(6 pages)

Unless otherwise specified in this document, apprentices shall be permitted only if they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor (DOL). The employer and the individual apprentice must be registered in a program which has received prior approval by the DOL. Any employer who employs an apprentice and is found to be in violation of this provision shall be required to pay said apprentice the full journeyman scale.

Attachments as listed above.

**\*Career Service Board approved to adjust all Davis Bacon classifications under \$17.29 to comply with the city's minimum wage. The effective date is January 1, 2023. See page 7 for reference.**

Office of Human Resources  
201 W. Colfax Ave. Dept. 412 | Denver, CO 80202  
p: 720.913.5751 | f: 720.913.5720  
[www.denvergov.org/humanresources](http://www.denvergov.org/humanresources)

"General Decision Number: CO20230009 01/06/2023

Superseded General Decision Number: CO20220009

State: Colorado

Construction Type: Highway

Counties: Denver and Douglas Counties in Colorado.

HIGHWAY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract.  . The contractor must pay all covered workers at least \$16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract.  . The contractor must pay all covered workers at least \$12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this



(3)-Loader (under 6 cu. yd.) Denver County.....	\$ 31.05	12.35
(3)-Motor Grader (blade-rough) Douglas County.....	\$ 31.05	12.35
(4)-Crane (50 tons and under), Scraper (single bowl, under 40 cu. yd).....	\$ 31.70	12.35
(4)-Loader (over 6 cu. yd) Denver County.....	\$ 31.20	12.35
(5)-Drill Rig Caisson (Watson 2500 similar or larger), Crane (51-90 tons), Scraper (40 cu.yd and over),.....	\$ 31.37	12.35
(5)-Motor Grader (blade-finish) Douglas County.....	\$ 31.37	12.35
(6)-Crane (91-140 tons).....	\$ 33.05	12.35

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SUCO2011-004 09/15/2011

	Rates	Fringes
CARPENTER (Excludes Form Work)....	\$ 19.27	5.08
CEMENT MASON/CONCRETE FINISHER		
Denver.....	\$ 20.18	5.75
Douglas.....	\$ 18.75	3.00
ELECTRICIAN (Excludes Traffic Signal Installation).....	\$ 35.13	6.83
FENCE ERECTOR (Excludes Link/Cyclone Fence Erection).....	\$ 13.02 **	3.20
GUARDRAIL INSTALLER.....	\$ 12.89 **	3.20
HIGHWAY/PARKING LOT STRIPING:Painter		
Denver.....	\$ 12.62 **	3.21
Douglas.....	\$ 13.89 **	3.21
IRONWORKER, REINFORCING (Excludes Guardrail Installation).....	\$ 16.69	5.45
IRONWORKER, STRUCTURAL (Includes Link/Cyclone Fence Erection, Excludes Guardrail Installation).....	\$ 18.22	6.01

## LABORER

Asphalt Raker.....	\$ 16.29	4.25
Asphalt Shoveler.....	\$ 21.21	4.25
Asphalt Spreader.....	\$ 18.58	4.65
Common or General		
Denver.....	\$ 16.76	6.77
Douglas.....	\$ 16.29	4.25
Concrete Saw (Hand Held)....	\$ 16.29	6.14
Landscape and Irrigation....	\$ 12.26 **	3.16
Mason Tender- Cement/Concrete		
Denver.....	\$ 16.96	4.04
Douglas.....	\$ 16.29	4.25
Pipelayer		
Denver.....	\$ 13.55 **	2.41
Douglas.....	\$ 16.30	2.18
Traffic Control (Flagger)....	\$ 9.55 **	3.05
Traffic Control (Sets Up/Moves Barrels, Cones, Install Signs, Arrow Boards and Place Stationary Flags) (Excludes Flaggers).....	\$ 12.43 **	3.22
PAINTER (Spray Only).....	\$ 16.99	2.87
POWER EQUIPMENT OPERATOR:		
Asphalt Laydown		
Denver.....	\$ 22.67	8.72
Douglas.....	\$ 23.67	8.47
Asphalt Paver		
Denver.....	\$ 24.97	6.13
Douglas.....	\$ 25.44	3.50
Asphalt Roller		
Denver.....	\$ 23.13	7.55
Douglas.....	\$ 23.63	6.43
Asphalt Spreader.....	\$ 22.67	8.72
Backhoe/Trackhoe		
Douglas.....	\$ 23.82	6.00
Bobcat/Skid Loader.....	\$ 15.37 **	4.28
Boom.....	\$ 22.67	8.72
Broom/Sweeper		
Denver.....	\$ 22.47	8.72
Douglas.....	\$ 22.96	8.22
Bulldozer.....	\$ 26.90	5.59
Concrete Pump.....	\$ 21.60	5.21
Drill		
Denver.....	\$ 20.48	4.71
Douglas.....	\$ 20.71	2.66
Forklift.....	\$ 15.91 **	4.68
Grader/Blade		

Denver.....	\$ 22.67	8.72
Guardrail/Post Driver.....	\$ 16.07 **	4.41
Loader (Front End)		
Douglas.....	\$ 21.67	8.22
Mechanic		
Denver.....	\$ 22.89	8.72
Douglas.....	\$ 23.88	8.22
Oiler		
Denver.....	\$ 23.73	8.41
Douglas.....	\$ 24.90	7.67
Roller/Compactor (Dirt and Grade Compaction)		
Denver.....	\$ 20.30	5.51
Douglas.....	\$ 22.78	4.86
Rotomill.....	\$ 16.22	4.41
Screed		
Denver.....	\$ 22.67	8.38
Douglas.....	\$ 29.99	1.40
Tractor.....	\$ 13.13 **	2.95

## TRAFFIC SIGNALIZATION:

## Groundsman

Denver.....	\$ 17.90	3.41
Douglas.....	\$ 18.67	7.17

## TRUCK DRIVER

## Distributor

Denver.....	\$ 17.81	5.82
Douglas.....	\$ 16.98	5.27

## Dump Truck

Denver.....	\$ 15.27 **	5.27
Douglas.....	\$ 16.39	5.27

Lowboy Truck.....	\$ 17.25	5.27
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Mechanic.....	\$ 26.48	3.50
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Multi-Purpose Specialty &  
Hoisting Truck

Denver.....	\$ 17.49	3.17
Douglas.....	\$ 20.05	2.88

## Pickup and Pilot Car

Denver.....	\$ 14.24 **	3.77
Douglas.....	\$ 16.43	3.68

Semi/Trailer Truck.....	\$ 18.39	4.13
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Truck Mounted Attenuator.....	\$ 12.43 **	3.22
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## Water Truck

Denver.....	\$ 26.27	5.27
Douglas.....	\$ 19.46	2.58

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WELDERS - Receive rate prescribed for craft performing  
operation to which welding is incidental.

**Office of Human Resources  
Supplemental Rates  
(Specific to the Denver Projects)  
Revised 01/01/2023)**

<b>Classification</b>		<b>Base</b>	<b>Fringe</b>
Guard Rail Installer		\$17.29	\$3.20
Highway Parking Lot Striping: Painter		\$17.29	\$3.21
Ironworker (Ornamental)		\$26.05	\$12.00
Laborer	Removal of Asbestos	\$21.03	\$8.55
Laborer (Landscape & Irrigation)		\$17.29	\$3.16
Laborer: Traffic Control (Flagger)		\$17.29	\$3.05
Laborer: Stationary Flags (excludes Flaggers)		\$17.29	\$3.22
Line Construction	Lineman, Gas Fitter/Welder	\$36.88	\$9.55
	Line Eq Operator/Line Truck Crew	\$25.74	\$8.09
Millwright		\$28.00	\$10.00
Pipefitter		\$30.45	\$12.85
Plumber		\$30.19	\$13.55
Power Equipment Operator (Tunnels Above and Below Ground, shafts and raises):	Group 1	\$25.12	\$10.81
	Group 2	\$25.47	\$10.85
	Group 3	\$25.57	\$10.86
	Group 4	\$25.82	\$10.88
	Group 5	\$25.97	\$10.90
	Group 6	\$26.12	\$10.91
	Group 7	\$26.37	\$10.94
Power Equipment Operator	Group 1	\$22.97	\$10.60
	Group 2	\$23.32	\$10.63
	Group 3	\$23.67	\$10.67
	Group 4	\$23.82	\$10.68
	Group 5	\$23.97	\$10.70
	Group 6	\$24.12	\$10.71
	Group 7	\$24.88	\$10.79
Truck Driver	Group 1	\$18.42	\$10.00
	Group 2	\$19.14	\$10.07
	Group 3	\$19.48	\$10.11
	Group 4	\$20.01	\$10.16
	Group 5	\$20.66	\$10.23
	Group 6	\$21.46	\$10.31
Truck Driver: Truck Mounted Attenuator		\$17.29	\$3.22

Go to <http://www.denvergov.org/Auditor> to view the Prevailing Wage Clarification Document for a list of complete classifications used.

**EXHIBIT E**  
**SPECIAL CONDITIONS**

**V. SPECIAL CONDITIONS****SC-1 CONSTRUCTION CONTRACT GENERAL CONDITIONS**

The Construction Contract General Conditions which constitute a part of the Contract Documents are set forth in a separately published document, entitled "City and County of Denver, Department of Aviation and Department of Public Works, Standard Specifications for Construction, General Contract Conditions," 2011 Edition, the Table of Contents to which is bound herein (which may be informally referred to as the Yellow Book). The General Conditions book is available for purchase for \$12.00 per copy at the following locations during the business hours stated, Monday through Friday, excluding holidays:

Office of the Cashier  
Wellington E. Webb Municipal Office Building, 2nd Floor  
201 West Colfax Avenue  
Denver, Colorado, USA 80202  
7:30 a.m. to 4:30 p.m.

The General Conditions are also available on the City and County of Denver website at:

<https://www.denvergov.org/content/denvergov/en/contract-administration/contractor-resources/general-contract-conditions.html>

**SC-2 DRAWINGS AND SPECIFICATIONS TO BE FURNISHED BY THE CITY**

The City will provide the following Contract Documents to the Contractor in electronic format at no expense to the Contractor:

1. TW DS East IFB Plan Drawings (IFB Dated 1/23/23)
2. TW DS East IFB Volume 1, Division 1 Specifications (Dated 1/23/23)
3. TW DS East IFB Volume 2, Technical Specifications (Dated 1/23/23)
4. TW DS East IFB Construction Safety and Phasing Plan (Dated 1/23/23)

Additional copies of the foregoing documents will be furnished to the Contractor at the Contractor's expense. The Contractor will be responsible for supplying all subcontractors with copies of the Contract Documents at its expense.

If Sensitive Security Information ("SSI") is provided to the Contractor, the Contractor shall be required to comply with Department of Aviation, Standard Policies and Procedures No. 6003, "Contractor Protection of Sensitive Security Information," or its successor, and 49 C.F.R. § 1520, or its successor.

The City will not supply any copies of the General Contract Conditions to the Contractor at City expense.

**SC-3 REVISIONS TO G.C. 201**

The second sentence of General Condition 201 is amended to read: "The unit responsible for this management and control is the Airport Infrastructure Management Office under the supervision of the Senior Vice President for Maintenance and Airport Infrastructure Management."

**SC-4 CITY LINE OF AUTHORITY AND CONTACTS**

In accordance with General Condition 214, the City's line of authority for administration of this Contract is: Chief Executive Officer (CEO). Executive Office, 9th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249. Any reference to the Manager of Aviation shall also mean Chief Executive Officer, Department of Aviation (CEO).

Executive Vice President – Chief Construction and Infrastructure Officer (EVP-CCIO) who reports to the CEO. Airport Infrastructure Management office, 9th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Senior Vice President - Airport Infrastructure Management (SVP-AIM) who reports to the COO. Airport Infrastructure Management office, 10th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Director of Infrastructure and Quality Assurance, reports to the SVP-AIM. The Project Manager reports to the Director of Infrastructure and Quality Assurance. Airport Infrastructure Management Division, 7<sup>th</sup> Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Project Manager, the City representative who has day to day administrative responsibility of this Contract, and who reports to the SVP-AIM. All notices, requests, pay applications (pursuant to G.C. 902), and other correspondence from the Contractor shall be sent to the assigned Project Manager unless otherwise provided in this Contract. The Project Manager for this Contract is: Chris Unzicker, Airport Infrastructure Management Office, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249, phone 303-342-2200.

The CEO may from time to time substitute a different City official as the designated “SVP-AIM” hereunder, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor SVP-AIM. The SVP-AIM may from time to time change the assigned Project Manager, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor Project Manager.

#### **SC-5 CONTRACTOR PERFORMANCE; SUBCONTRACTING**

With respect to General Condition 501, no more than sixty percent (60%) of the work may be subcontracted. If it is determined to be in the City’s best interest, this percentage may be modified throughout the course of the project by the SVP-AIM.

#### **SC-6 COOPERATION WITH OTHERS**

The Technical Specifications describe the constraints on the physical work site areas. These descriptions are not exhaustive, and the Contractor is required to coordinate its activities and work as may be required to meet FAA or City requirements while performing work on DEN.

Without limiting the foregoing, the following contracts administered by the City involve or may involve work overlapping or adjoining the Work under this Contract and may be prosecuted concurrently with the Work performed under this Contract. There may also be other adjoining or overlapping contracts which are not listed.

<u>Contract Number</u>	<u>Description</u>
201952248	Runway 17L-35R Complex Rehabilitation
TBD	Concourse C C40-/C42 Rehabilitation
202158849	Taxiway EE
202263079	West Gates DIW Expansion

#### **SC-7 PROSECUTION AND COMPLETION OF THE WORK:**

The Work to be performed under the Contract is described in the Technical Specifications and Contract Drawings. The Contractor shall complete the Work within 411 consecutive calendar days from Notice to Proceed.

The Work to be performed under the Contract may be divided into the Milestone Areas which are described in

the Technical Specifications or Contract Drawings. The Contractor shall complete the work included within these areas within the number of days set forth by the Project Manager.

#### **SC-8 LIQUIDATED DAMAGES**

If the Contractor fails to achieve Substantial Completion of the Work within each phase or the overall Contract Time, the Contractor shall be liable to the City for liquidated damages at the rate of Seven Thousand, Five Hundred Dollars (\$7,500.00) per day until substantial completion is achieved for that phase and/or overall Contract Term.

Article IV of the Contract and General Condition 602 cover payment and withholding of liquidated damages.

#### **SC-9 FACILITY SECURITY AND PERSONNEL ACCESS**

The Contractor shall conduct all its activities at the Airport in compliance with the Airport security system rules and regulations, which are administered by the Airport Operations Division. The Contractor shall obtain the proper access authorizations for its employees, subcontractors, and suppliers (i.e., Badges and Permits), and shall be responsible for such persons' compliance with all the Airport rules and regulations. A copy of the Contractors' section of the Airport Security rules and regulations are available for Contractor review at the Airport Access Services Office, Concourse A East Subcore, 4th Level. Persons regularly entering the construction areas must obtain personnel access badges from the Airport Access Services Office and must display badges, at all times, upon entering the construction, restricted and sterile areas of the airport. Any employee, subcontractor or supplier who violates such rules may be subject to revocation of his access authorization, including authorization for access to the construction site and all other restricted and sterile areas.

The security status of the Airport is subject to change without notice. These contract Special Conditions are applicable to the current security status of the Airport. Should the security status of the Airport change at any time during the term of this Contract, a written notice shall be issued to the Contractor detailing all applicable security modifications from the airport's current security status. The Contractor shall take **immediate steps** to comply with those security modifications as directed in the written notice.

If these security modifications involve any additional project cost, the Contractor shall submit a Contractor Change Request in accordance with the General Conditions for the additional cost. The Contractor Change Request shall outline in specific detail the effects of the security modifications on the Contractor's performance of the Contract, and shall provide a detailed cost breakdown for each item for which the Contractor is requesting reimbursement.

The Contractor shall return to the City, at contract completion or termination, or upon demand by the City, all access keys issued to it by the City to all areas of the Airport. If the Contractor fails to return any such key or keys at contract completion or termination or upon demand by the City, the Contractor shall be liable to the City for all the City's costs, including the City's labor costs for employees, incurred in re-coring doors and any other work which is required to prevent compromise of the Airport security system. In order to collect such costs hereunder, the City may withhold funds in such amount from any amounts due and payable to the Contractor under this Contract.

The construction of all the Project / Task Items that involve the breaching of any airport perimeter security boundary or continued access to restricted access rooms or areas will require the posting of authorized contract security personnel to maintain required security controls. The Contractor's **Total Contract BID Amount** shall include the cost of providing security services to maintain control and supervision of any and all airport perimeter security boundary breaches and for the duration of work activities where access to restricted areas is required and until the airport perimeter security boundaries are reestablished.

When security boundaries are opened for any reason, the Contractor must maintain one hundred percent (100%) control and supervision for the entire time that the openings are present to prevent unauthorized access to the secure / restricted access areas.

**THE IMPORTANCE OF THIS SPECIAL CONDITION CANNOT BE OVER-EMPHASIZED. SEVERE FINANCIAL PENALTIES AS WELL AS CONTRACT TERMINATION COULD RESULT IF AIRPORT PERIMETER SECURITY REQUIREMENTS ARE NOT STRICTLY FOLLOWED. THE REQUIREMENT TO PROVIDE ONE HUNDRED PERCENT (100%) CONTROL AND SUPERVISION OF BREACHES IN THE AIRPORT'S PERIMETER SECURITY BOUNDARY IS ABSOLUTE. AT NO TIME, DURING WORK AND NON-WORK HOURS SHALL ANY BREACHES IN THE AIRPORT'S SECURITY PERIMETER BE UNSUPERVISED AND / OR UNSECURED.**

For off-hours of construction, the Contractor may choose to erect a temporary wall to close all perimeter openings. The wall construction shall be of sufficient materials and strength to prevent access to the airport's Sterile/Restricted Areas. The Contractor shall submit for review and approval, the details and materials for the temporary closure of security perimeter breaches for review and approval.

The Contractor will provide contract security guard services to maintain supervision of these openings. The security services must provide coverage to allow for lunch breaks, comfort breaks, etc. The security services **must** be obtained from the following contract security guard company:

Covenant Aviation Security, LLC  
1112 W. Boughton Road  
Suite 355  
Bolingbrook, IL 60440

DEN Contact:  
Covenant Management  
720-222-4774

All security guards provided for this project must have a Denver Airport SIDA Badge.

The DEN Security Guard Contractor may change between the bidding or Bid phase of this contract from Notice to Proceed to closure of all security perimeter breaches. The Contractor shall maintain a contractual relationship with the Security Guard Contractor holding the most current contract with Denver International Airport.

The Contractor shall continue to provide security of these areas until such time that the breaches in the airport's security perimeter have been permanently secured.

The Contractor shall submit a written security plan for approval to the Director of Airport Security prior to the start of construction on any work where a breach of the perimeter security boundaries is required.

#### **SC-10 CONSTRUCTION ACCESS**

The work site(s) is/are located at Denver International Airport, Northeast side of Concourse C. The Contractor shall have access to the work site via Gate P-27. The Contractor is responsible for ensuring that all of the Contractor's and Subcontractor's personnel have the ability to access and locate the areas of work where the scope is to be performed without additional escorting or supervision from DEN.

The City will not provide parking spaces for the Contractor's employees or subcontractor employees at the Airport. Arrangements for transportation and parking for all of its and its subcontractors' employees will be the responsibility of the Contractor. The Total Contract Bid Amount or Contract Amount shall include any and all costs associated with the Contractor's and subcontractors' employee parking. Information about parking facilities and charges is available from the Airport Parking Office. Refundable deposits are required for all parking passes.

Unless specifically required by the Contract Documents, the Contractor shall install no fences or other physical obstructions on or around any project work area without the approval of the City.

#### **SC-11 VEHICLE PERMITTING**

Vehicle access on the Airport Operation Area ("AOA") is controlled by and requires permission from the Airport Access Services Office. It is not anticipated that the Contractor will need to operate vehicles on the AOA to perform the Work. Only direct construction support vehicles and/or equipment will be allowed in the contractor's work areas or sites.

#### **SC-12 VENDORS AND SUPPLIERS**

The Contractor shall provide the Project Manager's office with a list of its equipment/material vendors and suppliers. Vendors or suppliers shall access the construction work areas via the Contractor's access route, described in SC-10 above. All delivery vehicles are subject to search.

#### **SC-13 COMMUNICATION DEVICES**

Any site communications devices, mobile communication devices or internet data devices used at DEN must be approved by DEN Technologies.

#### **SC-14 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS**

The Contractor and its officers, agents, and employees shall cooperate and comply with the provisions of Executive Order No. 94 and Attachment A thereto concerning the use, possession, or sale of alcohol or drugs. Violation of these provisions or refusal to cooperate with implementation of the policy can result in the City's barring the Contractor from City facilities or participating in City operations.

#### **SC-15 ATTORNEYS' FEES**

Colorado Revised Statute 38-26-107 requires that in the event any person or company files a verified statement of amounts due and unpaid in connection with a claim for labor and materials supplied on this project, the City shall withhold from payments to the Contractor sufficient funds to insure the payment of any such claims. Should the City and County of Denver be made a party to any lawsuit to enforce such unpaid claims or any lawsuit arising out of or relating to such withheld funds, Contractor agrees to pay to the City its costs and a reasonable attorney's fee. Because the City Attorney Staff does not bill the City for legal services on an hourly basis, Contractor agrees a reasonable fee shall be computed at the rate of two hundred dollars per hour of City Attorney time.

#### **SC-16 INSURANCE REQUIREMENTS**

In accordance with the provisions of Title 16 of the General Conditions, the minimum insurance requirements for this contract are set forth in Section II-15 of the Instructions to Bidders. The Contractor specifically agrees to comply with each condition, requirement or specification set forth in the attachment for each required coverage during all periods when the required coverages are in effect.

Contractor and sub-contractors shall procure and maintain until all of their obligations have been discharged, including any warranty periods under this Contract are satisfied, required insurance against claims for injury to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Contractor, his agents, representatives, employees or sub-contractors.

The insurance requirements herein are minimum requirements for this Contract and in no way limit the indemnity covenants contained in this Contract.

The City and County of Denver in no way warrants that the minimum limits contained herein are sufficient to

protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, his agents, representatives, employees or sub-contractors. The Contractor shall assess its own risks as it deems appropriate and/or prudent, maintain higher limits and/or broader coverages. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration or types.

Contractor shall furnish the City and County of Denver with certificates of insurance (ACORD form or equivalent approved by CCD) as required by this Contract. The certificates for each insurance policy are to be signed by a person authorized by the insurer to bind coverage on its behalf.

All certificates and any required endorsements are to be received and approved by the City before work commences. Each insurance policy required by this Contract must be in effect at or prior to commencement of work under this Contract and remain in effect for the duration of the project. Failure to maintain the insurance policies as required by this Contract or to provide evidence of renewal is a material breach of the Contract. All insurance coverages for sub-contractors shall be subject to the minimum requirements identified in the Exhibit. All sub-contractors' certificates and endorsements shall be received and approved by the Contractor before work commences. The City reserves the right to request copies of these certificates at any time.

All certificates required by this Contract shall be sent directly to [ContractAdminInvoices@flydenver.com](mailto:ContractAdminInvoices@flydenver.com). The City project/contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time.

The parties hereto understand and agree that the City and County of Denver, its officers, officials and employees, are relying on, and do not waive or intend to waive by any provisions of this Contract, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, §§ 24-10-101 - 120, C.R.S., or otherwise available to the City and County of Denver, its officers, officials and employees.

#### **SC-17 SUBCONTRACTOR RELEASES**

The release form referred to in General Condition 907 is attached to this Contract. It is entitled "Denver International Airport Partial Release."

#### **SC-18 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS**

This contract is subject and subordinate to the terms, reservations, restrictions, and conditions of any existing or future agreements between the City and the United States, the execution of which has been or may be required as a condition precedent to the transfer of federal rights or property to the City for airport purposes, and the expenditure of federal funds for airport purposes. The "Federal Requirements" section attached hereto is made a part of this Contract.

#### **SC-19 ESTIMATED QUANTITIES OF UNIT PRICED ITEMS**

The "total estimated quantity" of each unit price item as stated on the bid schedules shall be the estimated quantity which is used to determine the percentage of change in such item for purposes of G.C. 1104.7.

#### **SC-20 REVISIONS TO G.C. 1102**

G.C. 1102.2 is amended by replacing the phrase "Change Request" in all its occurrences in such G.C. with the phrase "Change Notice."

G.C. 1102.3 is amended by replacing the phrase "Field Order/Change Order Directive" in all its occurrences in such G.C. with the phrase "Change Order Directive."

**SC-21 LISTING OF ACCEPTABLE MANUFACTURERS**

The Technical Specifications list "Acceptable Manufacturers" for certain products. Such listing identifies manufacturers of certain products which have been determined by a preliminary review to be able to meet the basic product and/or system technical requirements. The listing is not intended to provide a blanket endorsement or acceptance of the manufacturer's specified products or product line. All products from listed manufacturers must meet the detailed requirements of the Technical Specifications. Products that do not meet all detailed Technical Specifications are not acceptable and will be rejected, regardless of whether the manufacturer was listed as "acceptable." The Contractor is responsible for determining the acceptability of all products under the Technical Specifications prior to submission of products for approval.

**SC-22 ACCESSIBLE PARKING SPACES, ACCESS AISLES AND ROUTES OF TRAVEL**

If any Work is performed in or adjacent to parking facilities at the Airport, the Contractor is responsible for compliance with this SC-30. "Accessible" parking spaces and access aisles as used in this SC-30 mean parking spaces and access aisles which are accessible for, and reserved for use by, persons with disabilities. These parking spaces and access aisles are designed and built to standards established by federal regulations implementing the Americans with Disabilities Act of 1990 ("ADA") and are marked by signage. "Accessible routes of travel" as used herein means routes through parking facilities which comply with ADA accessibility standards, including degree of slope and absence of obstructions.

Accessible routes of travel and accessible parking spaces and access aisles must be kept free of obstructions and construction debris at all times. No accessible parking spaces or access aisles or accessible routes of travel shall be relocated, blocked or rendered unusable unless the contractor has obtained specific advance approval in writing for such actions from the airport's ADA Compliance Officer.

When prosecution of the Work requires that accessible spaces be temporarily blocked, those accessible spaces and their access aisles shall be temporarily relocated to another location as close as possible to an accessible building entrance. Temporary signage that identifies these parking spaces and access aisles as reserved for the handicapped shall be installed, and the accessible route shall be clearly marked as required.

Before blocking or relocating accessible parking spaces or accessible routes of travel, the contractor must obtain written approval from the DEN ADA Compliance Officer, by submitting a completed request form, which will be provided to the Contractor by the Project Manager at the preconstruction meeting if it is not included as a standard form in Section 019990 of the Technical Specifications. The request shall include the location of alternative spaces and/or routes, and specifications of the temporary signage to be used. Work shall not proceed without this approval.

If a vehicle is parked in any accessible space which is either temporary or approved to be relocated, the contractor will not remove signage or take any other action which would allow the access aisle for such parking space to be blocked. Such actions must be postponed until the parking space is no longer occupied.

**SC-23 SUBCONTRACTOR PAYMENTS AND SUBCONTRACTOR RELEASES – REQUIRED USE OF THE B2G CONTRACT MANAGEMENT SYSTEM**

The Contractor is required to use the City B2G Contract Management System to report all subcontractor payments and shall adhere to the City's Procedure for Reporting Subcontractor Payments. It is the Contractor's obligation to ensure that complete subcontractor information is entered into the B2G System prior to submission of the first application for payment in order to avoid any delays in payment. The Contractor shall, prior to the submission of each subsequent invoice, ensure payments to subcontractors have been entered into the B2G System, including subcontractor confirmation of amount of payment received, for services performed during the prior billing period.

**SC-24 PAYMENTS TO CONTRACTORS**

The Contractor recognizes and agrees that applications for payment shall be submitted using the Textura® Payment Management System (PPM System), which will also be the payment mechanism to disburse payments to sub-contractors used on this Project. For more information, please refer to Division I, Technical Specifications.

The Contractor further agrees that, to the fullest possible within the TPM System, the City shall be entitled to all non-Confidential records, reports, data and other information related to the project that are available to Contractor through the TPM System, including, but not limited to, information related to Contractor and subcontractor billings. To that end, Contractor agrees that it will activate any available settings within the TPM System that are necessary to grant the City access to such non-Confidential information related to the contract and the project. Applications for payment shall be based on the Contract Unit Prices or the approved Schedule of Values described in GC 903.1

In accordance with General Contract Condition 902, PAYMENT PROCEDURE, the party(ies) responsible for review of all Pay Applications shall be:

**Agency/Firm**

DEN Division CA  
DEN Division PM  
DEN Division Director  
DEN Contract Procurement CA  
CCD Denver Prevailing Wage

In accordance with General Contract Condition 906, APPLICATIONS FOR PAYMENT, each Application submitted shall include the following:

1. The estimate of Work completed shall be based on the approved schedule of values or unit prices, as applicable, and the percent of the Work complete.
2. Each Application for Payment shall include each and every independent subcontractor's payroll information including pay dates and pay amounts.
3. The Contractor shall also submit to the Auditor and other appropriate officials of the City in a timely fashion, information required by General Contract Condition 1004, REPORTING WAGES PAID.

In accordance with General Contract condition 907, RELEASES AND CONTRACTORS' CERTIFICATION OF PAYMENT, Applications for Payment must be accompanied by a completed Partial or Final Claim Release Form, as appropriate, from EACH subcontractor and supplier, **AND** the Contractor's Certification of Payment Form.

**SC-25 CONFIRMATION OF LAWFUL EMPLOYMENT**

General Condition 311 is deleted in its entirety and replaced by:

**311 No employment of a worker without authorization to perform work under the agreement.**

1. This Agreement is subject to Division 5 of Article IV of Chapter 20 of the Denver Revised Municipal Code, and any amendments (the "Certification Ordinance").
2. The Contractor certifies that:

- A. At the time of its execution of this Agreement, it does not knowingly employ or contract with a worker without authorization who will perform work under this Agreement, nor will it knowingly employ or contract with a worker without authorization to perform work under this Agreement in the future.
  - B. It will participate in the E-Verify Program, as defined in § 8-17.5-101(3.7), C.R.S., and confirm the employment eligibility of all employees who are newly hired for employment to perform work under this Agreement.
  - C. It will not enter into a contract with a subconsultant or subcontractor that fails to certify to the Contractor that it shall not knowingly employ or contract with a worker without authorization to perform work under this Agreement.
  - D. It is prohibited from using the E-Verify Program procedures to undertake pre-employment screening of job applicants while performing its obligations under this Agreement, and it is required to comply with any and all federal requirements related to use of the E-Verify Program including, by way of example, all program requirements related to employee notification and preservation of employee rights.
  - E. If it obtains actual knowledge that a subconsultant or subcontractor performing work under this Agreement knowingly employs or contracts with a worker without authorization, it will notify such subconsultant or subcontractor and the City within three (3) days. The Contractor shall also terminate such subconsultant or subcontractor if within three (3) days after such notice the subconsultant or subcontractor does not stop employing or contracting with the worker without authorization, unless during the three-day period the subconsultant or subcontractor provides information to establish that the subconsultant or subcontractor has not knowingly employed or contracted with a worker without authorization.
  - F. It will comply with a reasonable request made in the course of an investigation by the Colorado Department of Labor and Employment under authority of § 8-17.5-102(5), C.R.S., or the City Auditor, under authority of D.R.M.C. 20-90.3.
3. The Contractor is liable for any violations as provided in the Certification Ordinance. If the Contractor violates any provision of this section or the Certification Ordinance, the City may terminate this Agreement for a breach of the Agreement. If this Agreement is so terminated, the Contractor shall be liable for actual and consequential damages to the City. Any termination of a contract due to a violation of this section or the Certification Ordinance may also, at the discretion of the City, constitute grounds for disqualifying the Contractor from submitting bids or proposals for future contracts with the City.

**EXHIBIT F**

**City and County of Denver**



**D E N V E R**  
**THE MILE HIGH CITY**

**DEPARTMENT OF AVIATION  
DEPARTMENT OF PUBLIC WORKS**

**STANDARD SPECIFICATIONS FOR  
CONSTRUCTION  
GENERAL CONTRACT CONDITIONS**

**2011 Edition**

**Statement**

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**CONSTRUCTION CONTRACT GENERAL CONDITIONS  
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Liberty Bond No. 015219985  
Travelers Bond No. 107766496  
F&D/Zurich Bond No. 9416629  
Federal Bond No. K41614225  
Continental Bond No. 30172839  
Berkshire Bond No. 47-SUR-300033-01-0702

**PERFORMANCE BOND**

**KNOW ALL MEN BY THESE PRESENTS**, that we, the undersigned Flatiron Constructors, Inc., a corporation organized under the laws of the State of Delaware, hereinafter referred to as the "Contractor" and SEE ATTACHMENT A, a corporation organized under the laws of the State of SEE ATTACHMENT A, and authorized to transact business in the State of Colorado, hereinafter referred to as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", in the penal sum of **Sixty Million, Four Hundred Sixty-One Thousand, Seven Hundred Seventy and 05/100 Dollars** (\$ 60,461,770.05 ), lawful money of the United States of America, for the payment of which sum the Contractor and Surety bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally by these presents.

**WHEREAS**, the above Contractor has, as of the date of execution listed on the contract signature page, entered into a written contract with the City for furnishing all labor, materials, equipment, tools, superintendence, and other facilities and accessories for the construction of Contract No. IFB No. 202366450, Taxiway DS East and Deicing Pad, at Denver International Airport, in accordance with the Technical Specifications, Contract Drawings and all other Contract Documents therefor which are incorporated herein by reference and made a part hereof, and are herein referred to as the Contract.

**NOW, THEREFORE**, the condition of this performance bond is such that if the Contractor:

1. Promptly and faithfully observes, abides by and performs each and every covenant, condition and part of said Contract, including, but not limited to, its warranty provisions, in the time and manner prescribed in the Contract, and
2. Pays the City all losses, damages (liquidated or actual, including, but not limited to, damages caused by delays in the performance of the Contract), expenses, costs and attorneys' fees, that the City sustains resulting from any breach or default by the Contractor under the Contract, then this bond is void; otherwise, it shall remain in full force and effect.

**IN ADDITION**, if said Contractor fails to duly pay for any labor, materials, team hire, sustenance, provisions, provender, or any other supplies used or consumed by said Contractor or its subcontractors in its performance of the work contracted to be done or fails to pay any person who supplies rental machinery, tools, or equipment, all amounts due as the result of the use of such machinery, tools, or equipment in the prosecution of the work, the Surety shall pay the same in an amount not exceeding the amount of this obligation, together with interest as provided by law.

**PROVIDED FURTHER**, that the said Surety, for value received, hereby stipulates and agrees that any and all changes in the Contract or compliance or noncompliance with the formalities in the Contract for making such changes shall not affect the Surety's obligations under this bond and the Surety hereby waives notice of any such changes.

(End of Page)

IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 13th day of March, 2023.

By:   
Kevin McCormick  
DIVISION FINANCE MANAGER



Flatiron Constructors, Inc.  
CONTRACTOR

By:   
President GRANT JOHNS  
VICE PRESIDENT

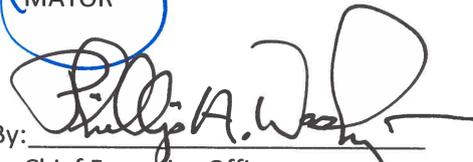
SEE ATTACHMENT A  
SURETY

By: SEE ATTACHMENT A  
Attorney-in-Fact

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond.)

CITY AND COUNTY OF DENVER

By:   
MAYOR

By:   
Chief Executive Officer  
Denver International Airport

APPROVED AS TO FORM:

KERRY TIPPER, Attorney for the City and County of Denver

By:   
Assistant City Attorney

## ATTACHMENT A

Liberty Mutual Insurance Company, a Massachusetts Corporation  
Travelers Casualty and Surety Company of America, a Connecticut corporation  
Fidelity and Deposit Company of Maryland, an Illinois corporation  
Zurich American Insurance Company, a New York corporation  
Federal Insurance Company, an Indiana corporation  
The Continental Insurance Company, a Pennsylvania Corporation  
Berkshire Specialty Insurance Company, a Nebraska Corporation

**Liberty Mutual Insurance Company – A.M. Best Rating A XV; NAIC# 23043**

175 Berkeley Street, Boston, MA 02116; Tel.: (212) 719-7750; Fax (212) 221-5608

Contact: David D. Roberts, Branch Manager, [davidd.roberts@libertymutual.com](mailto:davidd.roberts@libertymutual.com)

**Mailing Address for Claims Notices:**

Sam E. Barker, Director-AsiaPac, Global Risk Claims

[Sam.barker@libertymutual.com](mailto:Sam.barker@libertymutual.com) or [HOSCL@Libertymutual.com](mailto:HOSCL@Libertymutual.com)

Safeco Plaza, 1001 4<sup>th</sup> Avenue, Suite 3800

Seattle, WA 98154

**Bond No. 015219985**

**Travelers Casualty and Surety Company of America – A.M. Best Rating A++ XV; NAIC# 31194**

Construction Services, One Tower Square, Hartford, CT 06183; Tel.: (860) 277-1914; Fax (860) 277-3931

Contact: Jacob Fulmer, Regional Underwriting Officer, [jfulmer1@travelers.com](mailto:jfulmer1@travelers.com)

**Bond No. 107766496**

**Fidelity and Deposit Company of Maryland - A.M. Best Rating A+ XV; NAIC# 39306**

**Zurich American Insurance Company - A.M. Best Rating A+ XV; NAIC# 16535**

1299 Zurich Way, 5<sup>th</sup> Floor, Schaumburg, IL 60196; Tel.: (410) 559-8739; Fax (410) 261-7957

Contact: Douglas Sauer, Underwriting Officer, [douglas.sauer@zurichna.com](mailto:douglas.sauer@zurichna.com)

**Bond No. 9416629**

**Federal Insurance Company – A.M. Best Rating A++ XV; NAIC# 20281**

202B Hall's Mill Road, Whitehouse Station, NJ 08889; Tel.: (908) 903-4868; Fax (908) 903-3656

Contact: Brock Masterson, Senior VP/Director Construction Surety, [brock.masterson@chubb.com](mailto:brock.masterson@chubb.com)

**Bond No. K41614225**

**The Continental Insurance Company – A.M. Best Rating A XV; NAIC# 35289**

151 N Franklin Street, Chicago, IL 60606; Tel.: (212) 440-7356; Fax (212) 440-7351

Contact: Jon Fullerton, Branch Manager, [jon.fullerton@cnsurety.com](mailto:jon.fullerton@cnsurety.com)

**Bond No. 30172839**

**Berkshire Specialty Insurance Company – A.M. Best Rating A++ XV; NAIC# 22276**

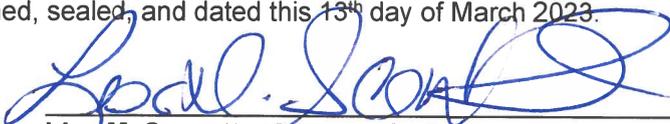
1314 Douglas Street, Suite 1400, Omaha, NE 68102; Tel.: (617) 936-2971; Fax (N/A)

Contact: Courtney T. Walker, Senior Vice President Surety, [courtney.walker@bhspecialty.com](mailto:courtney.walker@bhspecialty.com)

**Bond No. 47-SUR-300033-01-0702**

Signed, sealed, and dated this 13<sup>th</sup> day of March 2023.

By:

  
\_\_\_\_\_  
**Lisa M. Scavetta, Attorney-In-Fact**

Turner Surety and Insurance Brokerage, Inc.

250 Pehle Avenue, Suite 311, Saddle Brook, NJ 07663

Office: 201-267-7507 | Fax: 201-267-7532

Email: [lscavetta@tsibinc.com](mailto:lscavetta@tsibinc.com) | CA License # 0E81386

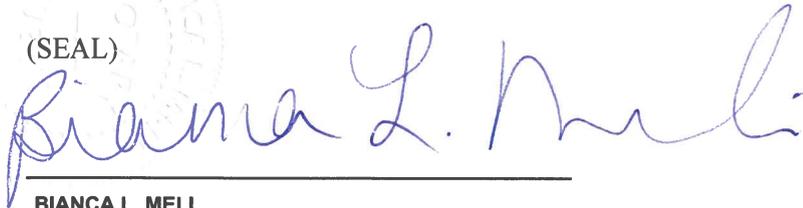
**CORPORATE ACKNOWLEDGMENT**

Form 152

STATE OF NEW JERSEY  
COUNTY OF BERGEN

On this 13<sup>th</sup> day of March, 2023 before me personally came Lisa M. Scavetta to me known, who, being by me duly sworn, did depose and say that she/he resides in Bronxville, New York that she/he is the ATTORNEY IN FACT of the LIBERTY MUTUAL INSURANCE COMPANY, TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, FIDELITY AND DEPOSIT COMPANY OF MARYLAND, ZURICH AMERICAN INSURANCE COMPANY, FEDERAL INSURANCE COMPANY, THE CONTINENTAL INSURANCE COMPANY, BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, the corporation described in and which executed the above instrument that she/he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that she/he signed her/his name thereto by like order.

(SEAL)



BIANCA L. MELI

NOTARY PUBLIC, STATE OF NEW JERSEY  
MY COMMISSION EXPIRES

SEPTEMBER 30, 2024



LIBERTY MUTUAL INSURANCE COMPANY  
FINANCIAL STATEMENT — DECEMBER 31, 2021

Assets		Liabilities	
Cash and Bank Deposits .....	\$2,234,770,744	Unearned Premiums .....	\$9,106,965,847
*Bonds — U.S Government .....	4,250,615,811	Reserve for Claims and Claims Expense .....	25,279,158,493
*Other Bonds .....	16,983,165,862	Funds Held Under Reinsurance Treaties .....	315,537,902
*Stocks .....	20,075,458,019	Reserve for Dividends to Policyholders .....	1,726,291
Real Estate .....	182,250,567	Additional Statutory Reserve .....	139,634,000
Agents' Balances or Uncollected Premiums .....	7,607,687,836	Reserve for Commissions, Taxes and Other Liabilities .....	8,638,106,801
Accrued Interest and Rents .....	120,173,987	<b>Total .....</b>	<b>\$43,481,129,334</b>
Other Admitted Assets .....	14,076,622,575	Special Surplus Funds .....	\$178,192,363
		Capital Stock .....	10,000,075
		Paid in Surplus .....	11,804,736,755
		Unassigned Surplus .....	10,056,686,874
<b>Total Admitted Assets .....</b>	<b><u>\$65,530,745,401</u></b>	<b>Surplus to Policyholders .....</b>	<b>22,049,616,067</b>
		<b>Total Liabilities and Surplus .....</b>	<b><u>\$65,530,745,401</u></b>



\* Bonds are stated at amortized or investment value; Stocks at Association Market Values.  
The foregoing financial information is taken from Liberty Mutual Insurance Company's financial statement filed with the state of Massachusetts Department of Insurance.

I, TIM MIKOLAJEWSKI, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the foregoing is a true, and correct statement of the Assets and Liabilities of said Corporation, as of December 31, 2021, to the best of my knowledge and belief.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Corporation at Seattle, Washington, this 8<sup>th</sup> day of March, 2022.

*T Mikolajewski*

Assistant Secretary



This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

Certificate No: 8208613-974450

POWER OF ATTORNEY

KNOWN ALL PERSONS BY THESE PRESENTS: That The Ohio Casualty Insurance Company is a corporation duly organized under the laws of the State of New Hampshire, that Liberty Mutual Insurance Company is a corporation duly organized under the laws of the State of Massachusetts, and West American Insurance Company is a corporation duly organized under the laws of the State of Indiana (herein collectively called the "Companies"), pursuant to and by authority herein set forth, does hereby name, constitute and appoint, Bianca L. Meli; Charo J. Rosemond; James Baldassare, Jr.; John F. Surano; Krista A. Burke; Lisa M. Scavetta; Maria L. Spadaccini; Michael Dugan; Nicholas F. Walsh; Sherryanne M. DePirro

all of the city of Saddle Brook state of NJ each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents and shall be as binding upon the Companies as if they have been duly signed by the president and attested by the secretary of the Companies in their own proper persons.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Companies and the corporate seals of the Companies have been affixed thereto this 18th day of August, 2022.



Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

By: [Signature of David M. Carey]

David M. Carey, Assistant Secretary

State of PENNSYLVANIA
County of MONTGOMERY ss

On this 18th day of August, 2022 before me personally appeared David M. Carey, who acknowledged himself to be the Assistant Secretary of Liberty Mutual Insurance Company, The Ohio Casualty Company, and West American Insurance Company, and that he, as such, being authorized so to do, execute the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.



Commonwealth of Pennsylvania - Notary Seal
Teresa Pastella, Notary Public
Montgomery County
My commission expires March 28, 2025
Commission number 1126044
Member, Pennsylvania Association of Notaries

By: [Signature of Teresa Pastella]
Teresa Pastella, Notary Public

This Power of Attorney is made and executed pursuant to and by authority of the following By-laws and Authorizations of The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company which resolutions are now in full force and effect reading as follows:

ARTICLE IV - OFFICERS: Section 12. Power of Attorney.

Any officer or other official of the Corporation authorized for that purpose in writing by the chairman or the President, and subject to such limitation as the Chairman or the President may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Corporation to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Corporation by their signature and execution of any such instruments and to attach thereto the seal of the Corporation. When so executed, such instruments shall be as binding as if signed by the President and attested to by the Secretary. Any power or authority granted to any representative or attorney-in-fact under the provisions of this article may be revoked at any time by the Board, the Chairman, the President or by the officer or officers granting such power or authority.

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.

Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

Certificate of Designation - The President of the Company, acting pursuant to the Bylaws of the Company, authorizes David M. Carey, Assistant Secretary to appoint such attorneys-in-fact as may be necessary to act on behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

Authorization - By unanimous consent of the Company's Board of Directors, the Company consents that facsimile or mechanically reproduced signature of any assistant secretary of the Company, wherever appearing upon a certified copy of any power of attorney issued by the Company in connection with surety bonds, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

I, Renee C. Llewellyn, the undersigned, Assistant Secretary, The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy of the Power of Attorney executed by said Companies, is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 13th day of March, 2023.



By: [Signature of Renee C. Llewellyn]

Renee C. Llewellyn, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, currency rate, interest rate or residual value guarantees.

For bond and/or Power of Attorney (POA) verification inquiries, call 1-800-368-3683.

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA

HARTFORD, CONNECTICUT 06183

FINANCIAL STATEMENT AS OF DECEMBER 31, 2021

CAPITAL STOCK \$ 6,480,000

ASSETS		LIABILITIES & SURPLUS	
BONDS	\$ 4,427,068,873	LOSSES	\$ 1,224,258,147
STOCKS	90,892,083	LOSS ADJUSTMENT EXPENSES	157,266,812
CASH AND INVESTED CASH	3,976,380	COMMISSIONS	49,877,644
OTHER INVESTED ASSETS	4,609,133	OTHER EXPENSES	46,607,590
SECURITIES LENDING REINVESTED COLLATERAL ASSETS	7,433,086	TAXES, LICENSES AND FEES	16,655,025
INVESTMENT INCOME DUE AND ACCRUED	37,877,324	CURRENT FEDERAL AND FOREIGN INCOME TAXES	1,972,277
PREMIUM BALANCES	294,081,729	UNEARNED PREMIUMS	1,212,347,629
REINSURANCE RECOVERABLE	70,677,646	ADVANCE PREMIUM	1,824,313
NET DEFERRED TAX ASSET	60,156,960	POLICYHOLDER DIVIDENDS	14,256,052
OTHER ASSETS	3,286,703	CEDED REINSURANCE NET PREMIUMS PAYABLE	47,473,619
		AMOUNTS WITHHELD / RETAINED BY COMPANY FOR OTHERS	42,097,038
		REMITTANCES AND ITEMS NOT ALLOCATED	10,579,448
		PROVISION FOR REINSURANCE	6,873,132
		PAYABLE TO PARENT, SUBSIDIARIES AND AFFILIATES	40,373,235
		PAYABLE FOR SECURITIES LENDING	7,433,086
		ESCHEAT LIABILITY	537,132
		RETROACTIVE REINSURANCE RESERVE ASSUMED	816,092
		OTHER ACCRUED EXPENSES AND LIABILITIES	250,005
		TOTAL LIABILITIES	\$ 2,881,598,277
		CAPITAL STOCK	\$ 6,480,000
		PAID IN SURPLUS	433,803,760
		OTHER SURPLUS	1,678,177,878
		TOTAL SURPLUS TO POLICYHOLDERS	\$ 2,118,461,638
TOTAL ASSETS	\$ 5,000,059,915	TOTAL LIABILITIES & SURPLUS	\$ 5,000,059,915

STATE OF CONNECTICUT )  
 COUNTY OF HARTFORD ) SS.  
 CITY OF HARTFORD )

MICHAEL J. DOODY, BEING DULY SWORN, SAYS THAT HE IS VICE PRESIDENT - FINANCE, OF TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, AND THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT STATEMENT OF THE FINANCIAL CONDITION OF SAID COMPANY AS OF THE 31ST DAY OF DECEMBER, 2021.

*Michael J. Doody*  
 VICE PRESIDENT - FINANCE

SUBSCRIBED AND SWORN TO BEFORE ME THIS  
 17TH DAY OF MARCH, 2022

*Susan M. Weissleder*  
 NOTARY PUBLIC



SUSAN M. WEISSLEDER  
 Notary Public  
 My Commission Expires November 30, 2022



**Travelers Casualty and Surety Company of America  
Travelers Casualty and Surety Company  
St. Paul Fire and Marine Insurance Company**

**POWER OF ATTORNEY**

**KNOW ALL MEN BY THESE PRESENTS:** That Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company are corporations duly organized under the laws of the State of Connecticut (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint **Lisa M. Scavetta** of **SADDLE BROOK**, their true and lawful Attorney(s)-in-Fact to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

**IN WITNESS WHEREOF**, the Companies have caused this instrument to be signed, and their corporate seals to be hereto affixed, this **21st** day of **April**, 2021.



State of Connecticut

City of Hartford ss.

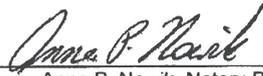
By:   
Robert L. Raney, Senior Vice President

On this the **21st** day of **April**, 2021, before me personally appeared **Robert L. Raney**, who acknowledged himself to be the Senior Vice President of each of the Companies, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of said Companies by himself as a duly authorized officer.

**IN WITNESS WHEREOF**, I hereunto set my hand and official seal.

My Commission expires the **30th** day of **June**, 2026



  
Anna P. Nowik, Notary Public

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of each of the Companies, which resolutions are now in full force and effect, reading as follows:

**RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

**FURTHER RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

**FURTHER RESOLVED**, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

**FURTHER RESOLVED**, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, **Kevin E. Hughes**, the undersigned, Assistant Secretary of each of the Companies, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which remains in full force and effect.

Dated this **13th** day of **March**, 2023.



  
Kevin E. Hughes, Assistant Secretary

**To verify the authenticity of this Power of Attorney, please call us at 1-800-421-3880.  
Please refer to the above-named Attorney(s)-in-Fact and the details of the bond to which this Power of Attorney is attached.**

**THE FIDELITY AND DEPOSIT COMPANY**

OF MARYLAND  
1299 Zurich Way Schaumburg, IL 60196

**Statement of Financial Condition**  
As Of December 31, 2021

**ASSETS**

Bonds.....	\$ 237,467,504
Stocks .....	18,985,762
Cash and Short-Term Investments .....	7,415,852
Reinsurance Recoverable .....	25,735,324
Federal Income Tax Recoverable.....	0
Other Accounts Receivable.....	24,479,233
<b>TOTAL ADMITTED ASSETS.....</b>	<b>\$ 314,083,675</b>

**LIABILITIES, SURPLUS AND OTHER FUNDS**

Reserve for Taxes and Expenses .....	\$ 378,101
Ceded Reinsurance Premiums Payable .....	48,876,599
Remittances and Items Unallocated .....	0
Payable to parents, subs and affiliates .....	0
Securities Lending Collateral Liability.....	0
<b>TOTAL LIABILITIES .....</b>	<b>\$ 49,254,700</b>
Capital Stock, Paid Up .....	\$ 5,000,000
Surplus.....	264,828,975
Surplus as regards Policyholders.....	264,828,975
<b>TOTAL .....</b>	<b>\$ 314,083,675</b>

Securities carried at \$78,561,855 in the above statement are deposited with various states as required by law.

Securities carried on the basis prescribed by the National Association of Insurance Commissioners. On the basis of market quotations for all bonds and stocks owned, the Company's total admitted assets at December 31, 2021 would be \$319,561,762 and surplus as regards policyholders \$270,307,062.

I, LAURA J. LAZARCZYK, Corporate Secretary of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company on the 31st day of December, 2021.

DocuSigned by:  
*Laura J. Lazarczyk*  
42DF60B471374B0...  
Corporate Secretary

State of Illinois }  
City of Schaumburg } SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15<sup>th</sup> day of March, 2022.



*Ryan Horgan*  
Notary Public

**ZURICH AMERICAN INSURANCE COMPANY**  
**COMPARATIVE BALANCE SHEET**  
**4 WORLD TRADE CENTER, 150 GREENWICH STREET, NEW YORK, NY 10007**  
**As of December 31, 2021 and December 31, 2020**

<u>Assets</u>	12/31/2021	12/31/2020
Bonds	\$ 16,632,198,754	\$ 15,696,060,158
Preferred Stock	-	-
Common Stock	2,938,741,320	2,964,630,407
Real Estate	1,195,108,770	1,294,160,876
Other Invested Assets	1,511,224,849	1,435,120,966
Derivatives	4,892,042	178,175
Short-term Investments	562,958	285,002
Receivable for securities	22,712,596	809,339
Cash and cash equivalents	157,712,608	526,475,686
Securities lending reinvested collateral assets	-	105,614,095
Employee Trust for Deferred Compensation Plan	114,975,842	122,225,149
Total Cash and Invested Assets	<u>\$ 22,578,129,739</u>	<u>\$ 22,145,559,853</u>
Premiums Receivable	\$ 5,896,173,688	\$ 5,318,928,254
Funds Held with Reinsurers	-	99,875
Reinsurance Recoverable	1,288,549,705	1,248,855,148
Accrued Investment Income	118,060,365	118,531,136
Federal Income Tax Recoverable	471,599,585	507,200,404
Due from Affiliates	129,012,120	92,277,523
Other Assets	538,603,889	559,476,243
Total Assets	<u>\$ 31,020,129,090</u>	<u>\$ 29,990,928,434</u>
<b><u>Liabilities and Policyholders' Surplus</u></b>		
<b>Liabilities:</b>		
Loss and LAE Reserves	\$ 12,244,569,908	\$ 12,295,705,961
Unearned Premium Reserve	4,276,836,095	3,952,940,831
Funds Held with Reinsurers	674,404,810	554,226,440
Loss In Course of Payment	1,673,061,383	1,351,312,377
Commission Reserve	160,324,275	119,930,116
Federal Income Tax Payable	10,641,098	34,772,832
Remittances and Items Unallocated	336,655,509	432,727,110
Payable to parent, subs and affiliates	353,084,887	273,601,687
Provision for Reinsurance	89,554,951	175,327,995
Ceded Reinsurance Premiums Payable	1,525,470,381	1,591,358,027
Securities Lending Collateral Liability	-	105,614,095
Other Liabilities	1,789,130,300	1,922,304,215
Total Liabilities	<u>\$ 23,133,733,598</u>	<u>\$ 22,809,821,689</u>
<b>Policyholders' Surplus:</b>		
Common Capital Stock	\$ 5,000,000	\$ 5,000,000
Paid-In and Contributed Surplus	4,394,131,321	4,394,131,321
Surplus Notes	-	-
Special Surplus Funds	3,996,000	9,672,000
Cumulative Unrealized Gain	172,586,977	192,450,057
Unassigned Surplus	3,310,681,195	2,579,853,368
Total Policyholders' Surplus	<u>\$ 7,886,395,493</u>	<u>\$ 7,181,106,746</u>
Total Liabilities and Policyholders' Surplus	<u>\$ 31,020,129,090</u>	<u>\$ 29,990,928,434</u>

I, LAURA J. LAZARCZYK, Corporate Secretary of ZURICH AMERICAN INSURANCE COMPANY do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company, on the 31st day of December, 2021, according to the best of my information, knowledge and belief.

DocuSigned by:

Laura J. Lazarczyk

420\*60847137480...

Corporate Secretary

State of Illinois  
 County of Cook

} SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15th day of March, 2022.



Notary public

**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND  
POWER OF ATTORNEY**

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Krista A. BURKE, Charo J. ROSEMOND, Maria L. SPADACCINI, Sherryanne M. DEPIRRO, Nicholas F. WALSH, Lisa M. SCAVETTA, James BALDASSARE, JR., John F. SURANO, Bianca L. MELI and Michael DUGAN of Saddle Brook, New Jersey**, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: **any and all bonds and undertakings**, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies, and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said **ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND**, this 8th day of December, A.D. 2022.



**ATTEST:**  
**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND**

By: *Robert D. Murray*  
Vice President

By: *Dawn E. Brown*  
Secretary

**State of Maryland  
County of Baltimore**

On this 8th day of December, A.D. 2022, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.

Iva Bethea  
Notary Public  
My Commission Expires September 30, 2023

**Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790**

**EXTRACT FROM BY-LAWS OF THE COMPANIES**

"Article V, Section 8, Attorneys-in-Fact. The Chief Executive Officer, the President, or any Executive Vice President or Vice President may, by written instrument under the attested corporate seal, appoint attorneys-in-fact with authority to execute bonds, policies, recognizances, stipulations, undertakings, or other like instruments on behalf of the Company, and may authorize any officer or any such attorney-in-fact to affix the corporate seal thereto; and may with or without cause modify or revoke any such appointment or authority at any time."

**CERTIFICATE**

I, the undersigned, Vice President of the ZURICH AMERICAN INSURANCE COMPANY, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing Power of Attorney is still in full force and effect on the date of this certificate; and I do further certify that Article V, Section 8, of the By-Laws of the Companies is still in force.

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the ZURICH AMERICAN INSURANCE COMPANY at a meeting duly called and held on the 15th day of December 1998.

RESOLVED: "That the signature of the President or a Vice President and the attesting signature of a Secretary or an Assistant Secretary and the Seal of the Company may be affixed by facsimile on any Power of Attorney...Any such Power or any certificate thereof bearing such facsimile signature and seal shall be valid and binding on the Company."

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at a meeting duly called and held on the 5th day of May, 1994, and the following resolution of the Board of Directors of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at a meeting duly called and held on the 10th day of May, 1990.

RESOLVED: "That the facsimile or mechanically reproduced seal of the company and facsimile or mechanically reproduced signature of any Vice-President, Secretary, or Assistant Secretary of the Company, whether made heretofore or hereafter, wherever appearing upon a certified copy of any power of attorney issued by the Company, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this 13th day of March, 2023.



*MJ Pethick*

By: Mary Jean Pethick  
Vice President

**TO REPORT A CLAIM WITH REGARD TO A SURETY BOND, PLEASE SUBMIT A COMPLETE DESCRIPTION OF THE CLAIM INCLUDING THE PRINCIPAL ON THE BOND, THE BOND NUMBER, AND YOUR CONTACT INFORMATION TO:**

Zurich Surety Claims  
1299 Zurich Way  
Schaumburg, IL 60196-1056  
Ph: 800-626-4577

If your jurisdiction allows for electronic reporting of surety claims, please submit to:  
[reportsfclaims@zurichna.com](mailto:reportsfclaims@zurichna.com)

**Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790**

**FEDERAL INSURANCE COMPANY**  
**STATEMENT OF ASSETS, LIABILITIES AND SURPLUS TO POLICYHOLDERS**

Statutory Basis

December 31, 2021

(in thousands)

ASSETS		LIABILITIES AND SURPLUS TO POLICYHOLDERS	
Cash and Short Term Investments	\$ (587,306)	Outstanding Losses and Loss Expenses	\$ 8,701,383
United States Government, State and Municipal Bonds	4,271,534	Reinsurance Payable on Losses and Expenses	1,484,196
Other Bonds	5,994,873	Unearned Premiums	2,400,711
Stocks	875,588	Ceded Reinsurance Premiums Payable	388,332
Other Invested Assets	<u>1,847,712</u>	Other Liabilities	<u>498,472</u>
<b>TOTAL INVESTMENTS</b>	<b><u>12,022,201</u></b>	<b>TOTAL LIABILITIES</b>	<b><u>13,451,084</u></b>
Investments in Affiliates:		Capital Stock	20,980
Great Northern Ins. Co.	414,838	Paid-In Surplus	2,711,474
Vigilant Ins. Co.	354,696	Unassigned Funds	<u>1,903,522</u>
Chubb Indemnity Ins. Co.	183,242	<b>SURPLUS TO POLICYHOLDERS</b>	<b><u>4,835,978</u></b>
Chubb National Ins. Co.	190,801		
Other Affiliates	116,373		
Premiums Receivable	1,726,853		
Other Assets	<u>3,078,466</u>		
 		<b>TOTAL LIABILITIES AND SURPLUS</b>	<b><u>\$18,087,070</u></b>
<b>TOTAL ADMITTED ASSETS</b>	<b><u>\$ 18,087,070</u></b>		

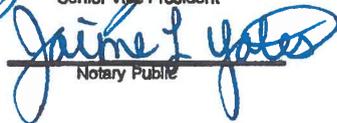
Investments are valued in accordance with requirements of the National Association of Insurance Commissioners. At December 31, 2021, investments with a carrying value of \$509,085,162 were deposited with government authorities as required by law.

STATE OF PENNSYLVANIA  
 COUNTY OF PHILADELPHIA

John Taylor, being duly sworn, says that he is Senior Vice President of Federal Insurance Company and that to the best of his knowledge and belief the foregoing is a true and correct statement of the said Company's financial condition as of the 31 st day of December, 2021.

Sworn before me this March 16, 2022

  
 Senior Vice President

  
 Notary Public

September 19, 2023  
 My commission expires

Commonwealth of Pennsylvania - Notary Seal  
 Jaime L. Yates, Notary Public  
 Philadelphia County  
 My commission expires September 19, 2023  
 Commission number 1357070  
 Member, Pennsylvania Association of Notaries



Power of Attorney

Federal Insurance Company | Vigilant Insurance Company | Pacific Indemnity Company  
Westchester Fire Insurance Company | ACE American Insurance Company

Know All by These Presents, that FEDERAL INSURANCE COMPANY, an Indiana corporation, VIGILANT INSURANCE COMPANY, a New York corporation, PACIFIC INDEMNITY COMPANY, a Wisconsin corporation, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint James Baldassare Jr., Krista A. Burke, Sherryanne M. DePirro, Michael Dugan, Bianca L. Meli, Charo J. Rosemond, Lisa M. Scavetta, Maria L. Spadaccini, John F. Surano and Nicholas F. Walsh of Saddle Brook, New Jersey

each as their true and lawful Attorney-in-Fact to execute under such designation in their names and to affix their corporate seals to and deliver for and on their behalf as surety thereon or otherwise, bonds and undertakings and other writings obligatory in the nature thereof (other than bail bonds) given or executed in the course of business, and any instruments amending or altering the same, and consents to the modification or alteration of any instrument referred to in said bonds or obligations.

In Witness Whereof, said FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY have each executed and attested these presents and affixed their corporate seals on this 8th day of December, 2022.

*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

*Stephen M. Haney*

Stephen M. Haney, Vice President



STATE OF NEW JERSEY  
County of Hunterdon

SS.

On this 8th day of December, 2022 before me, a Notary Public of New Jersey, personally came Dawn M. Chloros and Stephen M. Haney, to me known to be Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros and Stephen M. Haney, being by me duly sworn, severally and each for herself and himself did depose and say that they are Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and know the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that their signatures as such officers were duly affixed and subscribed by like authority.

Notarial Seal



Albert Contursi  
NOTARY PUBLIC OF NEW JERSEY  
No 50202369  
Commission Expires August 22, 2027

*Albert Contursi*  
Notary Public

CERTIFICATION

Resolutions adopted by the Boards of Directors of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY on August 30, 2016; WESTCHESTER FIRE INSURANCE COMPANY on December 11, 2006; and ACE AMERICAN INSURANCE COMPANY on March 20, 2009:

"RESOLVED, that the following authorizations relate to the execution, for and on behalf of the Company, of bonds, undertakings, recognizances, contracts and other written commitments of the Company entered into in the ordinary course of business (each a "Written Commitment"):

- (1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.
- (2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.
- (3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

FURTHER RESOLVED, that the foregoing Resolution shall not be deemed to be an exclusive statement of the powers and authority of officers, employees and other persons to act for and on behalf of the Company, and such Resolution shall not limit or otherwise affect the exercise of any such power or authority otherwise validly granted or vested."

I, Dawn M. Chloros, Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY (the "Companies") do hereby certify that

- (i) the foregoing Resolutions adopted by the Board of Directors of the Companies are true, correct and in full force and effect,
- (ii) the foregoing Power of Attorney is true, correct and in full force and effect.

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this 13th March 2023



*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

IN THE EVENT YOU WISH TO VERIFY THE AUTHENTICITY OF THIS BOND OR NOTIFY US OF ANY OTHER MATTER, PLEASE CONTACT US AT:  
Telephone (908) 903-3493 Fax (908) 903-3656 e-mail: surety@chubb.com

**THE CONTINENTAL INSURANCE COMPANY**  
**Radnor, Pennsylvania**  
**Statement of Net Admitted Assets and Liabilities**  
**December 31, 2021**

ASSETS

Bonds	\$ 1,572,724,833
Stocks	150,045,249
Cash and short-term investments	61,182,427
Receivables for securities	225,982
Investment income due and accrued	15,250,861
Amounts recoverable from reinsurers	66,552,237
Funds held by or deposited with reinsured companies	1,516,010
Current federal and foreign income tax recoverable and interest thereon	125
Net deferred tax asset	45,133,624
Premiums and considerations	67,900,494
Other assets	7,961,311
Total Assets	<u>\$ 1,988,493,153</u>

LIABILITIES AND SURPLUS

Losses	\$ 542,200,023
Loss adjustment expense	35,284,859
Unearned premiums	-
Other expenses	-
Federal and foreign income taxes payable	-
Ceded reinsurance premiums payable (net of ceding commissions)	57,149,295
Funds held by company under reinsurance treaties	5,172,467
Provision for reinsurance	26,200,000
Other liabilities	(489,610,082)
Total Liabilities	<u>\$ 176,396,562</u>

Surplus Account:

Capital paid up	\$ 53,566,360
Gross paid in and contributed surplus	1,423,436,994
Special Surplus	329,535,224
Unassigned funds	<u>5,558,013</u>
Surplus as regards policyholders	<u>\$ 1,812,096,591</u>
Total Liabilities and Capital	<u>\$ 1,988,493,153</u>

I, Julie Lee, Assistant Vice President of Continental Insurance Company hereby certify that the above is an accurate representation of the financial statement of the Company dated December 31, 2021, as filed with the various Insurance Departments and is a true and correct statement of the condition of Continental Insurance Company as of that date.



THE CONTINENTAL INSURANCE COMPANY

By Julie Lee  
Assistant Vice President, External Reporting

Subscribed and sworn to me this 14th day of March, 2022.

My commission expires:



By Christopher Lopatowski  
Notary Public

**POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT**

**Know All Men By These Presents**, That The Continental Insurance Company, a Pennsylvania insurance company, is a duly organized and existing insurance company having its principal office in the City of Chicago, and State of Illinois, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

**Maria L Spadaccini, James Baldassare Jr, Michael Dugan, Krista A Burke, Charo J Rosemond, Sherryanne M DePirro, John F Surano, Bianca L Meli, Lisa M Scavetta, Nicholas F Walsh, Individually**

of Saddle Brook, NJ, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

**- In Unlimited Amounts -**

and to bind them thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the insurance company and all the acts of said Attorney, pursuant to the authority hereby given is hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law and Resolutions, printed on the reverse hereof, duly adopted, as indicated, by the Board of Directors of the insurance company.

**In Witness Whereof**, The Continental Insurance Company has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 7th day of September, 2022.

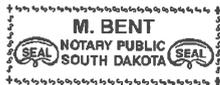


The Continental Insurance Company

*Paul T. Bruflat*  
Paul T. Bruflat Vice President

State of South Dakota, County of Minnehaha, ss:

On this 7th day of September, 2022, before me personally came Paul T. Bruflat to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is a Vice President of The Continental Insurance Company, a Pennsylvania insurance company, described in and which executed the above instrument; that he knows the seal of said insurance company; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said insurance company and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said insurance company.



My Commission Expires March 2, 2026

*M. Bent*  
M. Bent Notary Public

**CERTIFICATE**

I, D. Johnson, Assistant Secretary of The Continental Insurance Company, a Pennsylvania insurance company, do hereby certify that the Power of Attorney herein above set forth is still in force, and further certify that the By-Law and Resolution of the Board of Directors of the insurance company printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said insurance company this 13th day of March 2023



The Continental Insurance Company

*D. Johnson*  
D. Johnson Assistant Secretary

Form F6850-4/2012

Go to [www.cnasurety.com](http://www.cnasurety.com) > Owner / Obligee Services > Validate Bond Coverage, if you want to verify bond authenticity.

## Authorizing By-Laws and Resolutions

ADOPTED BY THE BOARD OF DIRECTORS OF THE CONTINENTAL INSURANCE COMPANY:

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the Board of Directors of the Company at a meeting held on May 10, 1995.

“RESOLVED: That any Group Vice President may authorize an officer to sign specific documents, agreements and instruments on behalf of the Company provided that the name of such authorized officer and a description of the documents, agreements or instruments that such officer may sign will be provided in writing by the Group Vice President to the Secretary of the Company prior to such execution becoming effective.

This Power of Attorney is signed by Paul T. Bruflat, Vice President, who has been authorized pursuant to the above resolution to execution power of attorneys on behalf of The Continental Insurance Company.

This Power of Attorney is signed and sealed by facsimile under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 25<sup>th</sup> day of April, 2012.

“Whereas, the bylaws of the Company or specific resolution of the Board of Directors has authorized various officers (the “Authorized Officers”) to execute various policies, bonds, undertakings and other obligatory instruments of like nature; and

Whereas, from time to time, the signature of the Authorized Officers, in addition to being provided in original, hard copy format, may be provided via facsimile or otherwise in an electronic format (collectively, “Electronic Signatures”), Now therefore be it resolved: that the Electronic Signature of any Authorized Officer shall be valid and binding on the Company.”

# BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY

1314 Douglas Street, Suite 1400, Omaha, Nebraska 68102-1944

## ADMITTED ASSETS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Total invested assets	\$ 6,504,184,299	\$ 5,475,240,588	\$ 5,172,183,338
Premium & agent balances (n	552,510,359	603,615,506	368,086,012
All other assets	142,765,038	157,897,676	127,524,677
<b>Admitted Assets</b>	<b>\$ 7,199,459,697</b>	<b>\$ 6,236,753,770</b>	<b>\$ 5,667,794,027</b>

## LIABILITIES & SURPLUS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Loss & loss exp. unpaid	\$ 1,142,116,028	\$ 921,923,948	\$ 634,745,558
Unearned premiums	484,660,143	372,836,160	314,117,549
All other liabilities	1,163,007,684	1,054,922,210	744,738,458
<b>Total Liabilities</b>	<b>2,789,783,855</b>	<b>2,349,682,318</b>	<b>1,693,601,565</b>
<b>Total Policyholders' Surplus:</b>	<b>4,409,675,842</b>	<b>3,887,071,452</b>	<b>3,974,192,463</b>
<b>Total Liabilities &amp; Surplus</b>	<b>\$ 7,199,459,697</b>	<b>\$ 6,236,753,770</b>	<b>\$ 5,667,794,028</b>

\* Assets, liabilities and surplus are presented on a Statutory Accounting Basis as promulgated by the NAIC and/or the laws of the company's domiciliary state.



### Power Of Attorney

#### BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY NATIONAL INDEMNITY COMPANY / NATIONAL LIABILITY & FIRE INSURANCE COMPANY

Know all men by these presents, that **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at One Lincoln Street, 23rd Floor, Boston, Massachusetts 02111, **NATIONAL INDEMNITY COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at 3024 Harney Street, Omaha, Nebraska 68131 and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Connecticut and having an office at 100 First Stamford Place, Stamford, Connecticut 06902 (hereinafter collectively the "Companies"), pursuant to and by the authority granted as set forth herein, do hereby name, constitute and appoint: **Lisa M. Scavetta, Sherryanne M. DePirro, Maria L. Spadaccini, Nicholas F. Walsh, James Baldassare, Jr., Krista A. Burke, Charo J. Rosemond, John F. Surano, Bianca L. Meli, Michael Dugan, 250 Pehle Avenue, Suite 311 of the city of Saddle Brook, State of New Jersey**, their true and lawful attorney(s)-in-fact to make, execute, seal, acknowledge, and deliver, for and on their behalf as surety and as their act and deed, any and all undertakings, bonds, or other such writings obligatory in the nature thereof, in pursuance of these presents, the execution of which shall be as binding upon the Companies as if it has been duly signed and executed by their regularly elected officers in their own proper persons. **This authority for the Attorney-in-Fact shall be limited to the execution of the attached bond(s) or other such writings obligatory in the nature thereof.**

In witness whereof, this Power of Attorney has been subscribed by an authorized officer of the Companies, and the corporate seals of the Companies have been affixed hereto this date of December 20, 2018. This Power of Attorney is made and executed pursuant to and by authority of the Bylaws, Resolutions of the Board of Directors, and other Authorizations of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY and NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, which are in full force and effect, each reading as appears on the back page of this Power of Attorney, respectively. **The following signature by an authorized officer of the Company may be a facsimile, which shall be deemed the equivalent of and constitute the written signature of such officer of the Company for all purposes regarding this Power of Attorney, including satisfaction of any signature requirements on any and all undertakings, bonds, or other such writings obligatory in the nature thereof, to which this Power of Attorney applies.**

**BERKSHIRE HATHAWAY SPECIALTY  
INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Executive Vice President



**NATIONAL INDEMNITY COMPANY,  
NATIONAL LIABILITY & FIRE INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Vice President

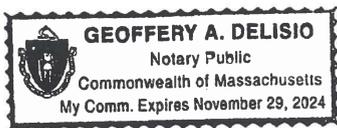


**NOTARY**

State of Massachusetts, County of Suffolk, ss:

On this 20th day of December, 2018, before me appeared David Fields, Executive Vice President of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY** and Vice President of **NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, who being duly sworn, says that his capacity is as designated above for such Companies; that he knows the corporate seals of the Companies; that the seals affixed to the foregoing instrument are such corporate seals; that they were affixed by order of the board of directors or other governing body of said Companies pursuant to its Bylaws, Resolutions and other Authorizations, and that he signed said instrument in that capacity of said Companies.

[Notary Seal]



Notary Public

I, Ralph Tortorella, the undersigned, Officer of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY and NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies which is in full force and effect and has not been revoked. IN TESTIMONY WHEREOF, see hereunto affixed the seals of said Companies this March 13, 2023.



Officer

To verify the authenticity of this Power of Attorney please contact us at: BHSI Surety Department, Berkshire Hathaway Specialty Insurance Company, One Lincoln Street, 23rd Floor Boston, MA 02111 | (770) 625-2516 or by email at [jennifer.porter@bhspecialty.com](mailto:jennifer.porter@bhspecialty.com). **THIS POWER OF ATTORNEY IS VOID IF ALTERED**  
To notify us of a claim please contact us on our 24-hour toll free number at (855) 453-9675, via email at [claimsnotice@bhspecialty.com](mailto:claimsnotice@bhspecialty.com), via fax to (617) 507-8259, or via mail.

**BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY (BYLAWS)**

ARTICLE V.

CORPORATE ACTIONS

....

EXECUTION OF DOCUMENTS:

....

Section 6.(b) The President, any Vice President or the Secretary, shall have the power and authority:

- (1) To appoint Attorneys-in-fact, and to authorize them to execute on behalf of the Company bonds and other undertakings, and
- (2) To remove at any time any such Attorney-in-fact and revoke the authority given him.

**NATIONAL INDEMNITY COMPANY (BY-LAWS)**

Section 1. Officers, Agents, and Employees:

A. The officers shall be a President, one or more Vice Presidents, a Secretary, one or more Assistant Secretaries, a Treasurer, and one or more Assistant Treasurers none of whom shall be required to be shareholders or Directors and each of whom shall be elected annually by the Board of Directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the Board of Directors, and shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the Board of Directors; and the Board of Directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the corporation.

**NATIONAL INDEMNITY COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BY-LAWS)**

ARTICLE IV

Officers

Section 1. Officers, Agents and Employees:

A. The officers shall be a president, one or more vice presidents, one or more assistant vice presidents, a secretary, one or more assistant secretaries, a treasurer, and one or more assistant treasurers, none of whom shall be required to be shareholders or directors, and each of whom shall be elected annually by the board of directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the board of directors. The president and secretary shall be different individuals. Election or appointment of an officer or agent shall not create contract rights. The officers of the Corporation shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the board of directors; and the board of directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the Corporation.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.

Liberty Bond No. 015219985  
Travelers Bond No. 107766496  
F&D/Zurich Bond No. 9416629  
Federal Bond No. K41614225  
Continental Bond No. 30172839  
Berkshire Bond No. 47-SUR-300033-01-0702

**PAYMENT BOND**

**KNOW ALL MEN BY THESE PRESENTS**, that we, the undersigned Flatiron Constructors, Inc., a corporation organized under the laws of the State of Delaware, hereinafter referred to as the "Contractor" and SEE ATTACHMENT A, a corporation organized under the laws of the State of SEE ATTACHMENT A, and authorized to transact business in the State of Colorado, hereinafter referred to as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", in the penal sum of Sixty Million, Four Hundred Sixty-One Thousand, Seven Hundred Seventy and 05/100 Dollars (\$ 60,461,770.05), lawful money of the United States of America, for the payment of which sum the Contractor and Surety bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

**WHEREAS**, the above Contractor has entered into a written contract with the City for furnishing all labor, materials, tools, superintendence, and other facilities and accessories for the construction of Contract No. IFB No. 202366450, Taxiway DS East and Deicing Pad, at Denver International Airport, in accordance with the Technical Specifications, Contract Drawings and all other Contract Documents therefor which are incorporated herein by reference and made a part hereof, and are herein referred to as the Contract.

**NOW, THEREFORE**, the condition of this payment bond obligation is such that if the Contractor shall at all times promptly make payments of all amounts lawfully due to all persons supplying or furnishing it or its subcontractors with labor and materials, rental machinery, tools, or equipment, used or performed in the prosecution of work provided for in the above Contract and shall indemnify and save harmless the City to the extent of any and all payments in connection with the carrying out of such Contract which the City may be required to make under the law, then this obligation shall be null and void, otherwise, it shall remain in full force and effect;

**PROVIDED FURTHER**, that the said Surety, for value received, hereby stipulates and agrees that any and all changes in the Contract, or compliance or noncompliance with the formalities in the Contract for making such changes shall not affect the Surety's obligations under this bond and the Surety hereby waives notice of any such changes.

[END OF PAGE]

IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 13th day of March, 2023.

By:   
KEVIN McCORMICK  
DIVISION FINANCE MANAGER



Flatiron Constructors, Inc.  
CONTRACTOR

By:   
President GRANT JOHNS  
VICE PRESIDENT

SEE ATTACHMENT A  
SURETY

By: SEE ATTACHMENT A  
Attorney-in-Fact

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond.)

CITY AND COUNTY OF DENVER

By:   
MAYOR

By:   
Chief Executive Officer  
Denver International Airport

APPROVED AS TO FORM:

KERRY TIPPER, Attorney for the City  
and County of Denver

By:   
Assistant City Attorney

## ATTACHMENT A

Liberty Mutual Insurance Company, a Massachusetts Corporation  
Travelers Casualty and Surety Company of America, a Connecticut corporation  
Fidelity and Deposit Company of Maryland, an Illinois corporation  
Zurich American Insurance Company, a New York corporation  
Federal Insurance Company, an Indiana corporation  
The Continental Insurance Company, a Pennsylvania Corporation  
Berkshire Specialty Insurance Company, a Nebraska Corporation

**Liberty Mutual Insurance Company – A.M. Best Rating A XV; NAIC# 23043**

175 Berkeley Street, Boston, MA 02116; Tel.: (212) 719-7750; Fax (212) 221-5608  
Contact: David D. Roberts, Branch Manager, [davidd.roberts@libertymutual.com](mailto:davidd.roberts@libertymutual.com)

**Mailing Address for Claims Notices:**

Sam E. Barker, Director-AsiaPac, Global Risk Claims  
[Sam.barker@libertymutual.com](mailto:Sam.barker@libertymutual.com) or [HOSCL@Libertymutual.com](mailto:HOSCL@Libertymutual.com)

Safeco Plaza, 1001 4<sup>th</sup> Avenue, Suite 3800  
Seattle, WA 98154

**Bond No. 015219985**

**Travelers Casualty and Surety Company of America – A.M. Best Rating A++ XV; NAIC# 31194**

Construction Services, One Tower Square, Hartford, CT 06183; Tel.: (860) 277-1914; Fax (860) 277-3931  
Contact: Jacob Fulmer, Regional Underwriting Officer, [jfulmer1@travelers.com](mailto:jfulmer1@travelers.com)

**Bond No. 107766496**

**Fidelity and Deposit Company of Maryland - A.M. Best Rating A+ XV; NAIC# 39306**

**Zurich American Insurance Company - A.M. Best Rating A+ XV; NAIC# 16535**

1299 Zurich Way, 5<sup>th</sup> Floor, Schaumburg, IL 60196; Tel.: (410) 559-8739; Fax (410) 261-7957  
Contact: Douglas Sauer, Underwriting Officer, [douglas.sauer@zurichna.com](mailto:douglas.sauer@zurichna.com)

**Bond No. 9416629**

**Federal Insurance Company – A.M. Best Rating A++ XV; NAIC# 20281**

202B Hall's Mill Road, Whitehouse Station, NJ 08889; Tel.: (908) 903-4868; Fax (908) 903-3656  
Contact: Brock Masterson, Senior VP/Director Construction Surety, [brock.masterson@chubb.com](mailto:brock.masterson@chubb.com)

**Bond No. K41614225**

**The Continental Insurance Company – A.M. Best Rating A XV; NAIC# 35289**

151 N Franklin Street, Chicago, IL 60606; Tel.: (212) 440-7356; Fax (212) 440-7351  
Contact: Jon Fullerton, Branch Manager, [jon.fullerton@cnsurety.com](mailto:jon.fullerton@cnsurety.com)

**Bond No. 30172839**

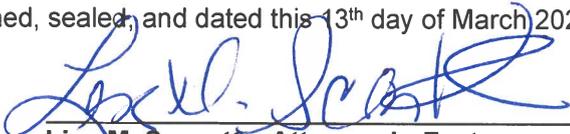
**Berkshire Specialty Insurance Company – A.M. Best Rating A++ XV; NAIC# 22276**

1314 Douglas Street, Suite 1400, Omaha, NE 68102; Tel.: (617) 936-2971; Fax (N/A)  
Contact: Courtney T. Walker, Senior Vice President Surety, [courtney.walker@bhspecialty.com](mailto:courtney.walker@bhspecialty.com)

**Bond No. 47-SUR-300033-01-0702**

Signed, sealed, and dated this 13<sup>th</sup> day of March 2023.

By:

  
**Lisa M. Scavetta, Attorney-In-Fact**

Turner Surety and Insurance Brokerage, Inc.  
250 Pehle Avenue, Suite 311, Saddle Brook, NJ 07663  
Office: 201-267-7507 | Fax: 201-267-7532  
Email: [lscavetta@tsibinc.com](mailto:lscavetta@tsibinc.com) | CA License # 0E81386

**CORPORATE ACKNOWLEDGMENT**

Form 152

STATE OF NEW JERSEY  
COUNTY OF BERGEN

On this 13<sup>th</sup> day of March, 2023 before me personally came Lisa M. Scavetta to me known, who, being by me duly sworn, did depose and say that she/he resides in Bronxville, New York that she/he is the ATTORNEY IN FACT of the LIBERTY MUTUAL INSURANCE COMPANY, TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, FIDELITY AND DEPOSIT COMPANY OF MARYLAND, ZURICH AMERICAN INSURANCE COMPANY, FEDERAL INSURANCE COMPANY, THE CONTINENTAL INSURANCE COMPANY, BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, the corporation described in and which executed the above instrument that she/he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that she/he signed her/his name thereto by like order.

(SEAL)



Bianca L. Meli

**BIANCA L. MELI**  
**NOTARY PUBLIC, STATE OF NEW JERSEY**  
**MY COMMISSION EXPIRES**  
**SEPTEMBER 30, 2024**



LIBERTY MUTUAL INSURANCE COMPANY  
FINANCIAL STATEMENT — DECEMBER 31, 2021

<b>Assets</b>		<b>Liabilities</b>	
Cash and Bank Deposits .....	\$2,234,770,744	Unearned Premiums .....	\$9,106,965,847
*Bonds — U.S Government .....	4,250,615,811	Reserve for Claims and Claims Expense .....	25,279,158,493
*Other Bonds .....	16,983,165,862	Funds Held Under Reinsurance Treaties .....	315,537,902
*Stocks .....	20,075,458,019	Reserve for Dividends to Policyholders .....	1,726,291
Real Estate .....	182,250,567	Additional Statutory Reserve .....	139,634,000
Agents' Balances or Uncollected Premiums .....	7,607,687,836	Reserve for Commissions, Taxes and Other Liabilities .....	8,638,106,801
Accrued Interest and Rents .....	120,173,987	<b>Total .....</b>	<b>\$43,481,129,334</b>
Other Admitted Assets .....	14,076,622,575	Special Surplus Funds .....	\$178,192,363
		Capital Stock .....	10,000,075
		Paid in Surplus .....	11,804,736,755
		Unassigned Surplus .....	10,056,686,874
<b>Total Admitted Assets .....</b>	<b><u>\$65,530,745,401</u></b>	<b>Surplus to Policyholders .....</b>	<b>22,049,616,067</b>
		<b>Total Liabilities and Surplus .....</b>	<b><u>\$65,530,745,401</u></b>



\* Bonds are stated at amortized or investment value; Stocks at Association Market Values.  
The foregoing financial information is taken from Liberty Mutual Insurance Company's financial statement filed with the state of Massachusetts Department of Insurance.

I, TIM MIKOLAJEWSKI, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the foregoing is a true, and correct statement of the Assets and Liabilities of said Corporation, as of December 31, 2021, to the best of my knowledge and belief.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Corporation at Seattle, Washington, this 8<sup>th</sup> day of March, 2022.

*TAMIKOLAJEWSKI*

Assistant Secretary



This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

Certificate No: 8208613-974450

POWER OF ATTORNEY

KNOWN ALL PERSONS BY THESE PRESENTS: That The Ohio Casualty Insurance Company is a corporation duly organized under the laws of the State of New Hampshire, that Liberty Mutual Insurance Company is a corporation duly organized under the laws of the State of Massachusetts, and West American Insurance Company is a corporation duly organized under the laws of the State of Indiana (herein collectively called the "Companies"), pursuant to and by authority herein set forth, does hereby name, constitute and appoint, Bianca L. Meli; Charo J. Rosemond; James Baldassare, Jr.; John F. Surano; Krista A. Burke; Lisa M. Scavetta; Maria L. Spadaccini; Michael Dugan; Nicholas F. Walsh; Sheryyanne M. DePirro

all of the city of Saddle Brook state of NJ each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents and shall be as binding upon the Companies as if they have been duly signed by the president and attested by the secretary of the Companies in their own proper persons.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Companies and the corporate seals of the Companies have been affixed thereto this 18th day of August, 2022.



Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

By: David M. Carey
David M. Carey, Assistant Secretary

State of PENNSYLVANIA ss
County of MONTGOMERY

On this 18th day of August, 2022 before me personally appeared David M. Carey, who acknowledged himself to be the Assistant Secretary of Liberty Mutual Insurance Company, The Ohio Casualty Company, and West American Insurance Company, and that he, as such, being authorized so to do, execute the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.



Commonwealth of Pennsylvania - Notary Seal
Teresa Pastella, Notary Public
Montgomery County
My commission expires March 28, 2025
Commission number 1126044
Member, Pennsylvania Association of Notaries

By: Teresa Pastella
Teresa Pastella, Notary Public

This Power of Attorney is made and executed pursuant to and by authority of the following By-laws and Authorizations of The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company which resolutions are now in full force and effect reading as follows:

ARTICLE IV - OFFICERS: Section 12. Power of Attorney.

Any officer or other official of the Corporation authorized for that purpose in writing by the Chairman or the President, and subject to such limitation as the Chairman or the President may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Corporation to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Corporation by their signature and execution of any such instruments and to attach thereto the seal of the Corporation. When so executed, such instruments shall be as binding as if signed by the President and attested to by the Secretary. Any power or authority granted to any representative or attorney-in-fact under the provisions of this article may be revoked at any time by the Board, the Chairman, the President or by the officer or officers granting such power or authority.

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.

Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

Certificate of Designation - The President of the Company, acting pursuant to the Bylaws of the Company, authorizes David M. Carey, Assistant Secretary to appoint such attorneys-in-fact as may be necessary to act on behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

Authorization - By unanimous consent of the Company's Board of Directors, the Company consents that facsimile or mechanically reproduced signature of any assistant secretary of the Company, wherever appearing upon a certified copy of any power of attorney issued by the Company in connection with surety bonds, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

I, Renee C. Llewellyn, the undersigned, Assistant Secretary, The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy of the Power of Attorney executed by said Companies, is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 13th day of March, 2023.



By: Renee C. Llewellyn
Renee C. Llewellyn, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, currency rate, interest rate or residual value guarantees.

For bond and/or Power of Attorney (POA) verification inquiries, please call 610-833-8240 or email LOCIID@libertymutual.com

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA

HARTFORD, CONNECTICUT 06183

FINANCIAL STATEMENT AS OF DECEMBER 31, 2021

CAPITAL STOCK \$ 6,480,000

ASSETS		LIABILITIES & SURPLUS	
BONDS	\$ 4,427,068,873	LOSSES	\$ 1,224,258,147
STOCKS	90,892,083	LOSS ADJUSTMENT EXPENSES	157,266,812
CASH AND INVESTED CASH	3,976,380	COMMISSIONS	49,977,644
OTHER INVESTED ASSETS	4,609,133	OTHER EXPENSES	46,607,590
SECURITIES LENDING REINVESTED COLLATERAL ASSETS	7,433,086	TAXES, LICENSES AND FEES	16,655,025
INVESTMENT INCOME DUE AND ACCRUED	37,877,324	CURRENT FEDERAL AND FOREIGN INCOME TAXES	1,972,277
PREMIUM BALANCES	294,081,729	UNEARNED PREMIUMS	1,212,347,629
REINSURANCE RECOVERABLE	70,677,646	ADVANCE PREMIUM	1,824,313
NET DEFERRED TAX ASSET	60,156,960	POLICYHOLDER DIVIDENDS	14,256,052
OTHER ASSETS	3,286,703	CEDED REINSURANCE NET PREMIUMS PAYABLE	47,473,619
		AMOUNTS WITHHELD / RETAINED BY COMPANY FOR OTHERS	42,097,038
		REMITTANCES AND ITEMS NOT ALLOCATED	10,579,448
		PROVISION FOR REINSURANCE	6,873,132
		PAYABLE TO PARENT, SUBSIDIARIES AND AFFILIATES	40,373,235
		PAYABLE FOR SECURITIES LENDING	7,433,086
		ESCHEAT LIABILITY	537,132
		RETROACTIVE REINSURANCE RESERVE ASSUMED	816,092
		OTHER ACCRUED EXPENSES AND LIABILITIES	250,005
		TOTAL LIABILITIES	\$ 2,881,598,277
		CAPITAL STOCK	\$ 6,480,000
		PAID IN SURPLUS	433,803,760
		OTHER SURPLUS	1,678,177,878
		TOTAL SURPLUS TO POLICYHOLDERS	\$ 2,118,461,638
TOTAL ASSETS	\$ 5,000,059,915	TOTAL LIABILITIES & SURPLUS	\$ 5,000,059,915

STATE OF CONNECTICUT )  
 COUNTY OF HARTFORD ) SS.  
 CITY OF HARTFORD )

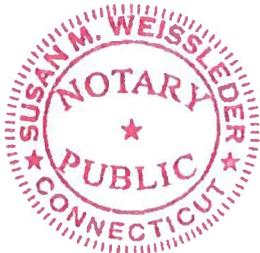
MICHAEL J. DOODY, BEING DULY SWORN, SAYS THAT HE IS VICE PRESIDENT - FINANCE, OF TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, AND THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT STATEMENT OF THE FINANCIAL CONDITION OF SAID COMPANY AS OF THE 31ST DAY OF DECEMBER, 2021.

*Michael J. Doody*  
 VICE PRESIDENT - FINANCE

*Susan M. Weissleder*  
 NOTARY PUBLIC

SUBSCRIBED AND SWORN TO BEFORE ME THIS  
 17TH DAY OF MARCH, 2022

SUSAN M. WEISSLEDER  
 Notary Public  
 My Commission Expires November 30, 2022





**Travelers Casualty and Surety Company of America  
Travelers Casualty and Surety Company  
St. Paul Fire and Marine Insurance Company**

**POWER OF ATTORNEY**

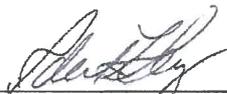
**KNOW ALL MEN BY THESE PRESENTS:** That Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company are corporations duly organized under the laws of the State of Connecticut (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint **Lisa M. Scavetta** of **SADDLE BROOK**, their true and lawful Attorney(s)-in-Fact to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

**IN WITNESS WHEREOF**, the Companies have caused this instrument to be signed, and their corporate seals to be hereto affixed, this **21st** day of **April**, 2021.



State of Connecticut

City of Hartford ss.

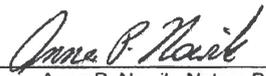
By:   
Robert L. Raney, Senior Vice President

On this the **21st** day of **April**, 2021, before me personally appeared **Robert L. Raney**, who acknowledged himself to be the Senior Vice President of each of the Companies, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of said Companies by himself as a duly authorized officer.

**IN WITNESS WHEREOF**, I hereunto set my hand and official seal.

My Commission expires the **30th** day of **June**, 2026



  
Anna P. Nowik, Notary Public

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of each of the Companies, which resolutions are now in full force and effect, reading as follows:

**RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

**FURTHER RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

**FURTHER RESOLVED**, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

**FURTHER RESOLVED**, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, **Kevin E. Hughes**, the undersigned, Assistant Secretary of each of the Companies, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which remains in full force and effect.

Dated this **13th** day of **March**, 2023.



  
Kevin E. Hughes, Assistant Secretary

**To verify the authenticity of this Power of Attorney, please call us at 1-800-421-3880.  
Please refer to the above-named Attorney(s)-in-Fact and the details of the bond to which this Power of Attorney is attached.**

**THE FIDELITY AND DEPOSIT COMPANY**

OF MARYLAND  
1299 Zurich Way Schaumburg, IL 60196

**Statement of Financial Condition**  
As Of December 31, 2021

**ASSETS**

Bonds.....	\$ 237,467,504
Stocks .....	18,985,762
Cash and Short-Term Investments .....	7,415,852
Reinsurance Recoverable .....	25,735,324
Federal Income Tax Recoverable.....	0
Other Accounts Receivable.....	24,479,233
<b>TOTAL ADMITTED ASSETS.....</b>	<b>\$ 314,083,675</b>

**LIABILITIES, SURPLUS AND OTHER FUNDS**

Reserve for Taxes and Expenses .....	\$ 378,101
Ceded Reinsurance Premiums Payable .....	48,876,599
Remittances and Items Unallocated .....	0
Payable to parents, subs and affiliates.....	0
Securities Lending Collateral Liability.....	0
<b>TOTAL LIABILITIES .....</b>	<b>\$ 49,254,700</b>
Capital Stock, Paid Up .....	\$ 5,000,000
Surplus.....	264,828,975
Surplus as regards Policyholders.....	264,828,975
<b>TOTAL .....</b>	<b>\$ 314,083,675</b>

Securities carried at \$78,561,855 in the above statement are deposited with various states as required by law.

Securities carried on the basis prescribed by the National Association of Insurance Commissioners. On the basis of market quotations for all bonds and stocks owned, the Company's total admitted assets at December 31, 2021 would be \$319,561,762 and surplus as regards policyholders \$270,307,062.

I, LAURA J. LAZARCZYK, Corporate Secretary of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company on the 31st day of December, 2021.

DocuSigned by:  
*Laura J. Lazarczyk*  
42DF6DB47137486...  
Corporate Secretary

State of Illinois }  
City of Schaumburg } SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15<sup>th</sup> day of March, 2022.



*Ryan Horgan*  
Notary Public

**ZURICH AMERICAN INSURANCE COMPANY**  
**COMPARATIVE BALANCE SHEET**  
**4 WORLD TRADE CENTER, 150 GREENWICH STREET, NEW YORK, NY 10007**  
**As of December 31, 2021 and December 31, 2020**

<u>Assets</u>	<u>12/31/2021</u>	<u>12/31/2020</u>
Bonds	\$ 16,632,198,754	\$ 15,696,060,158
Preferred Stock	-	-
Common Stock	2,938,741,320	2,964,630,407
Real Estate	1,195,108,770	1,294,160,876
Other Invested Assets	1,511,224,849	1,435,120,966
Derivatives	4,892,042	178,175
Short-term Investments	562,958	285,002
Receivable for securities	22,712,596	809,339
Cash and cash equivalents	157,712,608	526,475,686
Securities lending reinvested collateral assets	-	105,614,095
Employee Trust for Deferred Compensation Plan	114,975,842	122,225,149
Total Cash and Invested Assets	<u>\$ 22,578,129,739</u>	<u>\$ 22,145,559,853</u>
Premiums Receivable	\$ 5,896,173,688	\$ 5,318,928,254
Funds Held with Reinsurers	-	99,875
Reinsurance Recoverable	1,288,549,705	1,248,855,148
Accrued Investment Income	118,060,365	118,531,136
Federal Income Tax Recoverable	471,599,585	507,200,404
Due from Affiliates	129,012,120	92,277,523
Other Assets	538,603,889	559,476,243
Total Assets	<u>\$ 31,020,129,090</u>	<u>\$ 29,990,928,434</u>
<u>Liabilities and Policyholders' Surplus</u>		
<u>Liabilities:</u>		
Loss and LAE Reserves	\$ 12,244,569,908	\$ 12,295,705,961
Unearned Premium Reserve	4,276,836,095	3,952,940,831
Funds Held with Reinsurers	674,404,810	554,226,440
Loss In Course of Payment	1,673,061,383	1,351,312,377
Commission Reserve	160,324,275	119,930,116
Federal Income Tax Payable	10,641,098	34,772,832
Remittances and Items Unallocated	336,655,509	432,727,110
Payable to parent, subs and affiliates	353,084,887	273,601,687
Provision for Reinsurance	89,554,951	175,327,995
Ceded Reinsurance Premiums Payable	1,525,470,381	1,591,358,027
Securities Lending Collateral Liability	-	105,614,095
Other Liabilities	1,789,130,300	1,922,304,215
Total Liabilities	<u>\$ 23,133,733,598</u>	<u>\$ 22,809,821,689</u>
<u>Policyholders' Surplus:</u>		
Common Capital Stock	\$ 5,000,000	\$ 5,000,000
Paid-In and Contributed Surplus	4,394,131,321	4,394,131,321
Surplus Notes	-	-
Special Surplus Funds	3,996,000	9,672,000
Cumulative Unrealized Gain	172,586,977	192,450,057
Unassigned Surplus	3,310,681,195	2,579,853,368
Total Policyholders' Surplus	<u>\$ 7,886,395,493</u>	<u>\$ 7,181,106,746</u>
Total Liabilities and Policyholders' Surplus	<u>\$ 31,020,129,090</u>	<u>\$ 29,990,928,434</u>

I, LAURA J. LAZARCZYK, Corporate Secretary of ZURICH AMERICAN INSURANCE COMPANY do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company, on the 31st day of December, 2021, according to the best of my information, knowledge and belief.

DocuSigned by:

*Laura J. Lazarczyk*

42DF6DB47137480...

Corporate Secretary

State of Illinois  
 County of Cook

} SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15th day of March, 2022.

RYAN HORGAN  
 Official Seal  
 Notary Public - State of Illinois  
 My Commission Expires Dec 10, 2024

*Ryan Horgan*  
 Notary public

**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND  
POWER OF ATTORNEY**

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Krista A. BURKE, Charo J. ROSEMOND, Maria L. SPADACCINI, Sherryanne M. DEPIRRO, Nicholas F. WALSH, Lisa M. SCAVETTA, James BALDASSARE, JR., John F. SURANO, Bianca L. MELI and Michael DUGAN of Saddle Brook, New Jersey**, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: **any and all bonds and undertakings**, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies, and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND, this 8th day of December, A.D. 2022.



**ATTEST:**  
ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND

By: *Robert D. Murray*  
Vice President

By: *Dawn E. Brown*  
Secretary

**State of Maryland  
County of Baltimore**

On this 8th day of December, A.D. 2022, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.

Iva Betha  
Notary Public  
My Commission Expires September 30, 2023

**Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790**

**EXTRACT FROM BY-LAWS OF THE COMPANIES**

"Article V, Section 8, Attorneys-in-Fact. The Chief Executive Officer, the President, or any Executive Vice President or Vice President may, by written instrument under the attested corporate seal, appoint attorneys-in-fact with authority to execute bonds, policies, recognizances, stipulations, undertakings, or other like instruments on behalf of the Company, and may authorize any officer or any such attorney-in-fact to affix the corporate seal thereto; and may with or without cause modify or revoke any such appointment or authority at any time."

**CERTIFICATE**

I, the undersigned, Vice President of the ZURICH AMERICAN INSURANCE COMPANY, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing Power of Attorney is still in full force and effect on the date of this certificate; and I do further certify that Article V, Section 8, of the By-Laws of the Companies is still in force.

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the ZURICH AMERICAN INSURANCE COMPANY at a meeting duly called and held on the 15th day of December 1998.

RESOLVED: "That the signature of the President or a Vice President and the attesting signature of a Secretary or an Assistant Secretary and the Seal of the Company may be affixed by facsimile on any Power of Attorney...Any such Power or any certificate thereof bearing such facsimile signature and seal shall be valid and binding on the Company."

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at a meeting duly called and held on the 5th day of May, 1994, and the following resolution of the Board of Directors of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at a meeting duly called and held on the 10th day of May, 1990.

RESOLVED: "That the facsimile or mechanically reproduced seal of the company and facsimile or mechanically reproduced signature of any Vice-President, Secretary, or Assistant Secretary of the Company, whether made heretofore or hereafter, wherever appearing upon a certified copy of any power of attorney issued by the Company, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this 13th day of March, 2023.



*MJ Pethick*

By: Mary Jean Pethick  
Vice President

**TO REPORT A CLAIM WITH REGARD TO A SURETY BOND, PLEASE SUBMIT A COMPLETE DESCRIPTION OF THE CLAIM INCLUDING THE PRINCIPAL ON THE BOND, THE BOND NUMBER, AND YOUR CONTACT INFORMATION TO:**

Zurich Surety Claims  
1299 Zurich Way  
Schauinburg, IL 60196-1056  
Ph: 800-626-4577

If your jurisdiction allows for electronic reporting of surety claims, please submit to:  
[reportsfclaims@zurichna.com](mailto:reportsfclaims@zurichna.com)

Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790

**FEDERAL INSURANCE COMPANY**  
**STATEMENT OF ASSETS, LIABILITIES AND SURPLUS TO POLICYHOLDERS**

Statutory Basis

December 31, 2021

(in thousands)

ASSETS		LIABILITIES AND SURPLUS TO POLICYHOLDERS	
Cash and Short Term Investments	\$ (587,306)	Outstanding Losses and Loss Expenses	\$ 8,701,383
United States Government, State and Municipal Bonds	4,271,534	Reinsurance Payable on Losses and Expenses	1,484,198
Other Bonds	5,984,873	Unearned Premiums	2,400,711
Stocks	675,588	Ceded Reinsurance Premiums Payable	388,332
Other Invested Assets	<u>1,647,712</u>	Other Liabilities	<u>488,472</u>
<b>TOTAL INVESTMENTS</b>	<u><b>12,022,201</b></u>	<b>TOTAL LIABILITIES</b>	<u><b>13,451,094</b></u>
Investments in Affiliates:		Capital Stock	20,980
Great Northern Ins. Co.	414,638	Paid-In Surplus	2,711,474
Vigilant Ins. Co.	354,698	Unassigned Funds	<u>1,903,522</u>
Chubb Indemnity Ins. Co.	183,242	<b>SURPLUS TO POLICYHOLDERS</b>	<u><b>4,635,978</b></u>
Chubb National Ins. Co.	190,801		
Other Affiliates	116,373		
Premiums Receivable	1,726,653		
Other Assets	<u>3,078,486</u>		
<b>TOTAL ADMITTED ASSETS</b>	<u><b>\$ 18,087,070</b></u>	<b>TOTAL LIABILITIES AND SURPLUS</b>	<u><b>\$ 18,087,070</b></u>

Investments are valued in accordance with requirements of the National Association of Insurance Commissioners. At December 31, 2021, investments with a carrying value of \$508,085,182 were deposited with government authorities as required by law.

STATE OF PENNSYLVANIA

COUNTY OF PHILADELPHIA

John Taylor, being duly sworn, says that he is Senior Vice President of Federal Insurance Company and that to the best of his knowledge and belief the foregoing is a true and correct statement of the said Company's financial condition as of the 31 st day of December, 2021.

Sworn before me this March 16, 2022

  
 Senior Vice President

  
 Notary Public

September 19, 2023  
 My commission expires

Commonwealth of Pennsylvania - Notary Seal  
 Jaime L. Yates, Notary Public  
 Philadelphia County  
 My commission expires September 19, 2023  
 Commission number 1357070  
 Member, Pennsylvania Association of Notaries



Power of Attorney

Federal Insurance Company | Vigilant Insurance Company | Pacific Indemnity Company  
Westchester Fire Insurance Company | ACE American Insurance Company

Know All These Presents, that FEDERAL INSURANCE COMPANY, an Indiana corporation, VIGILANT INSURANCE COMPANY, a New York corporation, PACIFIC INDEMNITY COMPANY, a Wisconsin corporation, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint James Baldassare Jr., Krista A. Burke, Sherryanne M. DePirro, Michael Dugan, Bianca L. Meli, Charo J. Rosemond, Lisa M. Scavetta, Maria L. Spadaccini, John F. Surano and Nicholas F. Walsh of Saddle Brook, New Jersey -----

each as their true and lawful Attorney-in-Fact to execute under such designation in their names and to affix their corporate seals to and deliver for and on their behalf as surety thereon or otherwise, bonds and undertakings and other writings obligatory in the nature thereof (other than bail bonds) given or executed in the course of business, and any instruments amending or altering the same, and consents to the modification or alteration of any instrument referred to in said bonds or obligations.

In Witness Whereof, said FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY have each executed and attested these presents and affixed their corporate seals on this 8th day of December, 2022.

*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

*Stephen M. Haney*

Stephen M. Haney, Vice President



STATE OF NEW JERSEY  
County of Hunterdon ss.

On this 8th day of December, 2022 before me, a Notary Public of New Jersey, personally came Dawn M. Chloros and Stephen M. Haney, to me known to be Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros and Stephen M. Haney, being by me duly sworn, severally and each for herself and himself did depose and say that they are Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and know the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that their signatures as such officers were duly affixed and subscribed by like authority.

Notarial Seal



Albert Contursi  
NOTARY PUBLIC OF NEW JERSEY  
No 50202369  
Commission Expires August 22, 2027

*Albert Contursi*  
Notary Public

CERTIFICATION

Resolutions adopted by the Boards of Directors of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY on August 30, 2016; WESTCHESTER FIRE INSURANCE COMPANY on December 11, 2006; and ACE AMERICAN INSURANCE COMPANY on March 20, 2009:

"RESOLVED, that the following authorizations relate to the execution, for and on behalf of the Company, of bonds, undertakings, recognizances, contracts and other written commitments of the Company entered into in the ordinary course of business (each a "Written Commitment"):

- (1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.
- (2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.
- (3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

FURTHER RESOLVED, that the foregoing Resolution shall not be deemed to be an exclusive statement of the powers and authority of officers, employees and other persons to act for and on behalf of the Company, and such Resolution shall not limit or otherwise affect the exercise of any such power or authority otherwise validly granted or vested."

I, Dawn M. Chloros, Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY (the "Companies") do hereby certify that

- (i) the foregoing Resolutions adopted by the Board of Directors of the Companies are true, correct and in full force and effect,
- (ii) the foregoing Power of Attorney is true, correct and in full force and effect.

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this 13th March 2023



*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

IN THE EVENT YOU WISH TO VERIFY THE AUTHENTICITY OF THIS BOND OR NOTIFY US OF ANY OTHER MATTER, PLEASE CONTACT US AT:  
Telephone (908) 903-3493 Fax (908) 903-3656 e-mail: surety@chubb.com

**THE CONTINENTAL INSURANCE COMPANY**  
**Radnor, Pennsylvania**  
**Statement of Net Admitted Assets and Liabilities**  
**December 31, 2021**

ASSETS

Bonds	\$ 1,572,724,833
Stocks	150,045,249
Cash and short-term investments	61,182,427
Receivables for securities	225,982
Investment income due and accrued	15,250,861
Amounts recoverable from reinsurers	66,552,237
Funds held by or deposited with reinsured companies	1,516,010
Current federal and foreign income tax recoverable and interest thereon	125
Net deferred tax asset	45,133,624
Premiums and considerations	67,900,494
Other assets	7,961,311
<b>Total Assets</b>	<u>\$ 1,988,493,153</u>

LIABILITIES AND SURPLUS

Losses	\$ 542,200,023
Loss adjustment expense	35,284,859
Unearned premiums	-
Other expenses	-
Federal and foreign income taxes payable	-
Ceded reinsurance premiums payable (net of ceding commissions)	57,149,295
Funds held by company under reinsurance treaties	5,172,467
Provision for reinsurance	26,200,000
Other liabilities	(489,610,082)
<b>Total Liabilities</b>	<u>\$ 176,396,562</u>

Surplus Account:

Capital paid up	\$ 53,566,360
Gross paid in and contributed surplus	1,423,436,994
Special Surplus	329,535,224
Unassigned funds	5,558,013
Surplus as regards policyholders	<u>\$ 1,812,096,591</u>
<b>Total Liabilities and Capital</b>	<u>\$ 1,988,493,153</u>

I, Julie Lee, Assistant Vice President of Continental Insurance Company hereby certify that the above is an accurate representation of the financial statement of the Company dated December 31, 2021, as filed with the various Insurance Departments and is a true and correct statement of the condition of Continental Insurance Company as of that date.



THE CONTINENTAL INSURANCE COMPANY

By Julie Lee  
 Assistant Vice President, External Reporting

Subscribed and sworn to me this 14th day of March, 2022.

My commission expires:



By Christopher Lopatowski  
 Notary Public

**POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT**

**Know All Men By These Presents**, That The Continental Insurance Company, a Pennsylvania insurance company, is a duly organized and existing insurance company having its principal office in the City of Chicago, and State of Illinois, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

**Maria L Spadaccini, James Baldassare Jr, Michael Dugan, Krista A Burke, Charo J Rosemond, Sherryanne M DePirro, John F Surano, Bianca L Meli, Lisa M Scavetta, Nicholas F Walsh, Individually**

of Saddle Brook, NJ, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

**- In Unlimited Amounts -**

and to bind them thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the insurance company and all the acts of said Attorney, pursuant to the authority hereby given is hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law and Resolutions, printed on the reverse hereof, duly adopted, as indicated, by the Board of Directors of the insurance company.

**In Witness Whereof**, The Continental Insurance Company has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 7th day of September, 2022.

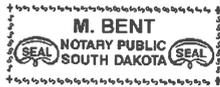


The Continental Insurance Company

*Paul T. Bruflat*  
Paul T. Bruflat Vice President

State of South Dakota, County of Minnehaha, ss:

On this 7th day of September, 2022, before me personally came Paul T. Bruflat to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is a Vice President of The Continental Insurance Company, a Pennsylvania insurance company, described in and which executed the above instrument; that he knows the seal of said insurance company; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said insurance company and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said insurance company.



My Commission Expires March 2, 2026

*M. Bent*  
M. Bent Notary Public

**CERTIFICATE**

I, D. Johnson, Assistant Secretary of The Continental Insurance Company, a Pennsylvania insurance company, do hereby certify that the Power of Attorney herein above set forth is still in force, and further certify that the By-Law and Resolution of the Board of Directors of the insurance company printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said insurance company this 13th day of March 2023



The Continental Insurance Company

*D. Johnson*  
D. Johnson Assistant Secretary

Form F6850-4/2012

Go to [www.cnasurety.com](http://www.cnasurety.com) > Owner / Oblige Services > Validate Bond Coverage, if you want to verify bond authenticity.

## Authorizing By-Laws and Resolutions

ADOPTED BY THE BOARD OF DIRECTORS OF THE CONTINENTAL INSURANCE COMPANY:

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the Board of Directors of the Company at a meeting held on May 10, 1995.

“RESOLVED: That any Group Vice President may authorize an officer to sign specific documents, agreements and instruments on behalf of the Company provided that the name of such authorized officer and a description of the documents, agreements or instruments that such officer may sign will be provided in writing by the Group Vice President to the Secretary of the Company prior to such execution becoming effective.

This Power of Attorney is signed by Paul T. Bruflat, Vice President, who has been authorized pursuant to the above resolution to execution power of attorneys on behalf of The Continental Insurance Company.

This Power of Attorney is signed and sealed by facsimile under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 25<sup>th</sup> day of April, 2012.

“Whereas, the bylaws of the Company or specific resolution of the Board of Directors has authorized various officers (the “Authorized Officers”) to execute various policies, bonds, undertakings and other obligatory instruments of like nature; and

Whereas, from time to time, the signature of the Authorized Officers, in addition to being provided in original, hard copy format, may be provided via facsimile or otherwise in an electronic format (collectively, “Electronic Signatures”), Now therefore be it resolved: that the Electronic Signature of any Authorized Officer shall be valid and binding on the Company.”

# BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY

1314 Douglas Street, Suite 1400, Omaha, Nebraska 68102-1944

## ADMITTED ASSETS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Total invested assets	\$ 6,504,184,299	\$ 5,475,240,588	\$ 5,172,183,338
Premium & agent balances (n	552,510,359	603,615,506	368,086,012
All other assets	142,765,038	157,897,676	127,524,677
<b>Admitted Assets</b>	<u>\$ 7,199,459,696</u>	<u>\$ 6,236,753,770</u>	<u>\$ 5,667,794,027</u>

## LIABILITIES & SURPLUS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Loss & loss exp. unpaid	\$ 1,142,116,028	\$ 921,923,948	\$ 634,745,558
Unearned premiums	484,660,143	372,836,160	314,117,549
All other liabilities	1,163,007,684	1,054,922,210	744,738,458
<b>Total Liabilities</b>	<u>2,789,783,855</u>	<u>2,349,682,318</u>	<u>1,693,601,565</u>
<b>Total Policyholders' Surplus</b>	<u>4,409,675,842</u>	<u>3,887,071,452</u>	<u>3,974,192,463</u>
<b>Total Liabilities &amp; Surplus</b>	<u>\$ 7,199,459,697</u>	<u>\$ 6,236,753,770</u>	<u>\$ 5,667,794,028</u>

\* Assets, liabilities and surplus are presented on a Statutory Accounting Basis as promulgated by the NAIC and/or the laws of the company's domiciliary state.



### Power Of Attorney

#### BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY NATIONAL INDEMNITY COMPANY / NATIONAL LIABILITY & FIRE INSURANCE COMPANY

Know all men by these presents, that **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at One Lincoln Street, 23rd Floor, Boston, Massachusetts 02111, **NATIONAL INDEMNITY COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at 3024 Harney Street, Omaha, Nebraska 68131 and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Connecticut and having an office at 100 First Stamford Place, Stamford, Connecticut 06902 (hereinafter collectively the "Companies"), pursuant to and by the authority granted as set forth herein, do hereby name, constitute and appoint: **Lisa M. Scavetta, Sherryanne M. DePirro, Maria L. Spadaccini, Nicholas F. Walsh, James Baldassare, Jr., Krista A. Burke, Charo J. Rosemond, John F. Surano, Bianca L. Meli, Michael Dugan, 250 Pehle Avenue, Suite 311 of the city of Saddle Brook, State of New Jersey**, their true and lawful attorney(s)-in-fact to make, execute, seal, acknowledge, and deliver, for and on their behalf as surety and as their act and deed, any and all undertakings, bonds, or other such writings obligatory in the nature thereof, in pursuance of these presents, the execution of which shall be as binding upon the Companies as if it has been duly signed and executed by their regularly elected officers in their own proper persons. **This authority for the Attorney-in-Fact shall be limited to the execution of the attached bond(s) or other such writings obligatory in the nature thereof.**

In witness whereof, this Power of Attorney has been subscribed by an authorized officer of the Companies, and the corporate seals of the Companies have been affixed hereto this date of December 20, 2018. This Power of Attorney is made and executed pursuant to and by authority of the Bylaws, Resolutions of the Board of Directors, and other Authorizations of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, which are in full force and effect, each reading as appears on the back page of this Power of Attorney, respectively. **The following signature by an authorized officer of the Company may be a facsimile, which shall be deemed the equivalent of and constitute the written signature of such officer of the Company for all purposes regarding this Power of Attorney, including satisfaction of any signature requirements on any and all undertakings, bonds, or other such writings obligatory in the nature thereof, to which this Power of Attorney applies.**

**BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Executive Vice President

**NATIONAL INDEMNITY COMPANY,  
NATIONAL LIABILITY & FIRE INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Vice President

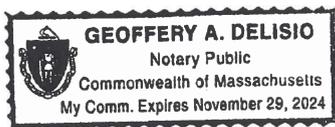


**NOTARY**

State of Massachusetts, County of Suffolk, ss:

On this 20th day of December, 2018, before me appeared David Fields, Executive Vice President of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY** and Vice President of **NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, who being duly sworn, says that his capacity is as designated above for such Companies; that he knows the corporate seals of the Companies; that the seals affixed to the foregoing instrument are such corporate seals; that they were affixed by order of the board of directors or other governing body of said Companies pursuant to its Bylaws, Resolutions and other Authorizations, and that he signed said instrument in that capacity of said Companies.

[Notary Seal]



Notary Public

I, Ralph Tortorella, the undersigned, Officer of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies which is in full force and effect and has not been revoked. IN TESTIMONY WHEREOF, see hereunto affixed the seals of said Companies this March 13, 2023.



Officer

To verify the authenticity of this Power of Attorney please contact us at: BHSI Surety Department, Berkshire Hathaway Specialty Insurance Company, One Lincoln Street, 23rd Floor Boston, MA 02111 | (770) 625-2516 or by email at [jennifer.porter@bhsispecialty.com](mailto:jennifer.porter@bhsispecialty.com) THIS POWER OF ATTORNEY IS VOID IF ALTERED  
To notify us of a claim please contact us on our 24-hour toll free number at (855) 453-9675, via email at [claims@bhsispecialty.com](mailto:claims@bhsispecialty.com), via fax to (617) 507-8259, or via mail.

**BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY (BYLAWS)**

ARTICLE V.

CORPORATE ACTIONS

....

EXECUTION OF DOCUMENTS:

....

Section 6.(b) The President, any Vice President or the Secretary, shall have the power and authority:

- (1) To appoint Attorneys-in-fact, and to authorize them to execute on behalf of the Company bonds and other undertakings, and
- (2) To remove at any time any such Attorney-in-fact and revoke the authority given him.

**NATIONAL INDEMNITY COMPANY (BY-LAWS)**

Section 4. Officers, Agents, and Employees:

A. The officers shall be a President, one or more Vice Presidents, a Secretary, one or more Assistant Secretaries, a Treasurer, and one or more Assistant Treasurers none of whom shall be required to be shareholders or Directors and each of whom shall be elected annually by the Board of Directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the Board of Directors, and shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the Board of Directors; and the Board of Directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the corporation.

**NATIONAL INDEMNITY COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BY-LAWS)**

ARTICLE IV

Officers

Section 1. Officers, Agents and Employees:

A. The officers shall be a president, one or more vice presidents, one or more assistant vice presidents, a secretary, one or more assistant secretaries, a treasurer, and one or more assistant treasurers, none of whom shall be required to be shareholders or directors, and each of whom shall be elected annually by the board of directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the board of directors. The president and secretary shall be different individuals. Election or appointment of an officer or agent shall not create contract rights. The officers of the Corporation shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the board of directors; and the board of directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the Corporation.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.



# PROJECT MANUAL

TAXIWAY DS EAST

CONTRACT NO. 201737642-02

## VOLUME I

GENERAL REQUIREMENTS

ISSUED FOR CONSTRUCTION

MARCH 6, 2023

CITY & COUNTY OF DENVER

DEPARTMENT OF AVIATION

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## VOLUME I – GENERAL REQUIREMENTS

### DIVISION 01 – GENERAL REQUIREMENTS

<b>SPEC</b>	<b>DESCRIPTION</b>
011100	Summary of Work
011400	Work Sequence and Constraints
011430	Vehicle and Equipment Permitting
011810	Utilities Interface
012300	Alternates
012510	Substitutions
012910	Schedule of Values
013100	Project Management and Coordination
013119	Project Meetings
013210	Schedule
013223.11	Construction Layout and As-Built Surveys
013223.15	Survey Information
013223.19	Quantity Surveys
013233	Photographic Documentation
013300	Submittal Procedures
013325	Shop and Working Drawings, Product Data, and Samples
013510	Construction Safety
013516	Alteration Project Procedures
014100	Regulatory Requirements
014210	Referenced Material
014220	Abbreviations and Symbols
014225	Reference Standards
014230	Definitions and Conventions
014320	DEN Quality Assurance for FAA Funded Projects
014520	Contractor Quality Control Program – FAA
014525	Material Testing Agency
014545	Special Inspection Agency and Owner Testing Agencies
015050	Mobilization
015210	Temporary Facilities
015215	Field Offices
015525	Traffic Control
015719	Temporary Environmental Controls
015810	Temporary Signs
016000	Product Requirements

016610	Storage and Protection
017330	Cutting and Patching
017419	Construction Waste Management and Disposal
017420	Cleaning
017515	System Startup, Testing, and Training
017720	Contract Closeout
017825	Operation and Maintenance Data
017835	Warranties and Bonds
017840	Contract Record Documents
017900	Demonstration and Training
019113	General Commissioning Requirements

**END OF SECTION**

**SECTION 011100**  
**SUMMARY OF WORK**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY AND DESCRIPTION**

- A. The Work specified in this contract consists of furnishing all management, supervision, labor, materials, tools, equipment, services, testing and incidentals for the construction of the Work indicated in the contract documents including lump sum items and unit price items.
- B. The Work in this Contract may affect operations at DEN. The Contractor shall bid, plan and execute the Work to minimize disruption of operations and inconvenience to the public.
- C. Change Notice:
1. The Contractor will be required to submit a proposal for each Change Notice
  2. The Contractor shall submit a proposal for the complete scope of the Work within the specified duration identified by the Notice. Where there is no time requirement identified by the notice documents, the Contractor shall submit a proposal within 20 days of receiving the notice or as allowed in Title 11 - Changes in the Work, Contract Price, or Contract Time of the General Contract Conditions, 2011 Edition.
  3. The proposal could contain both competitive bid and estimated costs and shall adhere to the requirements of Title 11 of the General Contract Conditions.
  4. The Contractor shall not proceed on any change notice work until a change order is issued.
- D. Change Directives:
1. The DEN Project Manager may issue Change Directive(s) for a Scope of Work. The Contractor shall keep all Time and Material record for any Change Directive(s) issued until a final settlement for the task is settled and finalized in a Change Order.
  2. The Contractor shall keep records and approvals for all Time and Material impacts of a Change Directive until a final settlement is reached and fully executed by the DEN Project Manager.
  3. The Contractor may invoice for a Change Directive in accordance with Title 11 of the General Contract Conditions, 2011 Edition.
- E. Guaranteed Maximum Price (GMP): For Contracts assigned as GMP the Contractor shall follow the Special Conditions issued for the Contract.
- F. This Project will be administered using the current Project Management Information System (PMIS). The application will be supplied by DEN at no cost to the Contractor. DEN will provide PMIS training for up to two (2) of the contractor's personnel.
- G. The Contractor shall participate in a preconstruction coordination meeting and update the

existing BIM Project Execution Plan or prepare a BIM Project Execution Plan if one does not exist based upon the DEN BIM Project Execution Plan (BPXP) template included as provided by the DEN Digital Facilities and Infrastructure (DFI) group and the coordination meeting instructions.

- H. DEN utilizes several programs as part of the Asset Management System. Keeping accurate as-built record and operation and maintenance data are essential in the integrity and the validity of the airport operation. The Contractor is required to make every effort to keep the airport data informed, updated and accurate in the format required by DEN Project Manager:
1. The Contractor shall provide and implement BIM Project Execution Plan based on the DEN BIM Project Execution Plan. The Contractor shall employ or contract a consultant to provide all the requirements to produce the Project model in the latest edition of AutoCAD Civil 3D. The model shall be submitted to DEN in electronic format.
  2. The Contractor shall comply with all the requirements of DEN BIM Project Execution Plan and provide the data to DEN to produce the complete record of the BIM model of the Project
- I. Inspection Requirements:
1. Special Inspection and Testing required by the building official or the Engineer of Record in the Contract Documents or in the Statement of Special Inspections will be performed by DEN contracted Agencies.
  2. Contractor shall subcontract Qualified Material Testing Agency(s) to perform all necessary Quality Control, processing control and any additional Testing required by the Contract Documents.
  3. DEN Quality Assurance Manager may audit all material tests performed by the Contractor Quality Control at any time. Testing and Inspections for structural elements (reinforced concrete, steel, masonry caissons, fire protection, precast and post tension concrete) not identified as special inspection will be performed by the Contractor Quality Control Program and Contractor Material Testing Agency and audited and confirmed by DEN Quality Assurance Manager. DEN will perform 100% visual inspection on all weldments. DEN will perform Quality Assurance testing at a frequency of approximately 10% of the Quality Control test and inspection frequencies. The testing frequencies by DEN may escalate to higher percentages and the Contractor will be responsible for all costs associated with failing tests of the same pay item elements. The Contractor may not hire the DEN contracted or testing agency in any capacity on this Project.
- J. DEN Quality Assurance will perform all quality assurance pull and adhesion tests on all airfield joint sealants. Contractor shall perform all quality control tests for the same items.
- K. DEN Quality Assurance is required to submit a letter indicating that all Work performed on the project complies with all applicable codes. The Contractor shall make sure that all required test frequencies and all deficiencies has been corrected to comply with all applicable codes and standards and the requirements of the Contract Documents.

### **1.03 WORK BY OTHERS AND FUTURE WORK**

- A. Refer to Title 7 – Cooperation, Coordination and Rate of Progress of the General Contract Conditions, 2011 Edition.

### **1.04 SITE CONDITIONS**

- A. Refer to Title 14 – Site Conditions of the General Contract Conditions, 2011 Edition.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 CONTRACTOR'S DUTIES**

- A. Refer to Title 3 – Contractor Performance and Services of the General Contract Conditions, 2011 Edition.
- B. Execute the Work as specified and in a timely manner. Submit a schedule of Work that will be performed at times other than during the eight-hour working day of Monday through Friday, daylight hours. Submit this schedule five (5) working days prior to the beginning of Work to the DEN Project Manager for review and acceptance. Approval to work at night may be obtained after Contractor presents a written program outlining special precautions to be taken to control the extraordinary hazards presented by night work. That program shall include, but not be limited to, supplementary lighting of work areas, availability of medical facilities, security precautions, and noise limitations.

### **3.02 COORDINATION**

- A. Coordinate execution of the Work with those public utilities, governmental bodies, private utilities and other contractors performing work on and adjacent to the worksites. Eliminate or minimize delays in the Work and conflicts with those utilities, bodies, and contractors. Schedule governmental, private utility and public utility work that relies upon survey points, lines and grades established by the Contractor to occur immediately after those points, lines and grades have been established. Confirm coordination measures for each individual case with the DEN Project Manager in writing.
- B. In the coordination effort of work by others, the Contractor shall obtain and refer to equipment locations and other layouts, as available, to avoid interface problems.
- C. The City reserves the right to permit access to the site of the Work for the performance of work by other contractors and persons at such times that the City deems proper. The exercise of such reserved right shall in no way or to any extent relieve the Contractor from liability for loss and damage to the Work due to or resulting from its operations or from responsibility for complete execution of the Contract. The Contractor shall cooperate with other contractors and persons in all matters requiring common effort.

### **3.03 CONTRACTOR USE OF WORK SITE**

- A. Confine work site operations to areas permitted by law, ordinances, permits, and the Contract.
- B. Consider the safety of the Work and that of the people and property on and adjacent to the work site when determining amount, location, movement, and use of materials and equipment on work site.
- C. Do not load work site with equipment and products that would interfere with the Work. Only equipment, tools, or materials required for this Work may be stored at the work site.
- D. Protect products, equipment, and materials stored on work site.

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 011100 - SUMMARY OF WORK**

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- E. Relocate stored products, equipment, and materials that interfere with operations of City, government bodies, public, and private utilities, and other contractors.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011100**

**SECTION 011400****WORK SEQUENCE AND CONSTRAINTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 OTHER WORK**

- A. Other concurrent construction contracts with which the Contractor must interface are described elsewhere in the Contract Documents. Refer to Section 013210 "Schedule" and the Special Conditions for specific work constraints and milestones.

**1.03 WORK SEQUENCE**

- A. The work sequence shall comply with Phasing, Sequencing, and Milestones as indicated in the Contract Documents and in accordance with the approved Construction Schedule developed by the Contractor. The schedule shall comply with requirements indicated in the Special Conditions and Section 011400 "Work Sequence and Constraints". The Construction Schedule is described in Section 013210 "Schedule".

**1.04 WORK CONSTRAINTS**

- A. Site Constraints:
1. Access to the Project shall be generally as indicated in the Contract Documents. Access shall be organized and planned by the Contractor to ensure no disruption of airline or DEN operations.
  2. Access to work sites will be strictly monitored and must comply with DEN Airport Operations and FAA Regulations. The Contractor shall provide monitoring and escorts as required by DEN Operations in the area of the Work.
  3. The Contractor's staging area will be as indicated in the Construction Documents.
  4. Contractor employee parking will not be allowed within the existing revenue control system. Parking facilities will be as indicated in the Construction Documents.
  5. The Contractor shall use the haul routes specified in the Construction Documents.
  6. If required, the Contractor shall provide a bus and driver to transport the Contractor's employees between the designated employee parking area and the work sites. No separate payment will be made for this bus and driver. The cost shall be included in the bid item "Mobilization". The bus driver shall be provided at all times when Contractor employees are working on the Project.
- B. System Interruptions:
1. DEN is a 24/7/365 facility. Construction activity that requires any system shutdown must be coordinated with the project manager and DEN AIM MCC.
  2. The Shutdown cannot proceed unless all approver groups have approved the request. If any of the groups rejects the request, you may not proceed with the Shutdown. If a Shutdown is determined to be an emergency due to pending health issues or the risk of additional damage, this process may be bypassed. If the Shutdown is an

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 011400 – WORK SEQUENCE AND CONSTRAINTS**

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emergency, proceed with the shutdown without the approvals. Approvals must be obtained as follows

- a. Airfield Shutdowns must be submitted at least 72 hours prior to the shutdown start date.
- b. All other Shutdowns must be submitted at least five (5) business days prior to the shutdown start date.
- c. All Shutdown Requests must be submitted using the Shutdown Request form, which can be accessed via the Home page of the DEN intranet.

**C. Airfield Operations at Denver International Airport:**

1. Full airport and aircraft operations are underway adjacent to this Project. Contractors are required to obtain a Contractor Participant Manual from the Security Manager and must follow the guidelines in the manual. Copies of the Contractor section of the manual are available for review at the Denver International Airport Access Services Office.
  - a. If any Work contains requirements for Work activities or access through or in the restricted area, reference Section 011420 "Security Requirements & Sensitive Security Information (SSI)" for requirements.
  - b. If not in a restricted area, the Contractor personnel still must be badged; reference Section 011420 "Security Requirements & Sensitive Security Information (SSI)".

**D. Conduct of persons using the Denver Municipal Airport system:**

1. Contractor activities shall comply with Airport Operations and Regulation 130 "TRAFFIC" and Regulation 20 "CONDUCT OF PERSONS USING THE DENVER MUNICIPAL AIRPORT SYSTEM" shall be followed at all times. These regulations are available from Airport Operations at Denver International Airport.

**E. Operational safety on airports during construction:**

1. All Work shall be accomplished in accordance with FAA Advisory Circular AC150/5370-2 (current edition), "Operational Safety on Airports during Construction", FAR Part 139 and FAR Part 107 except as herein modified.

**F. Welding Equipment, Procedures and Constraints:**

1. Natural gas-powered portable welders or inverter single- and three-phase electric portable welders are the only acceptable welding equipment to be used inside the building basement or tunnel areas. Acceptability of equipment other than the equipment noted above shall be at the sole discretion of the DEN Project Manager.
2. Welding activities inside buildings require submittal of a System Interruption Request (See paragraph "System Interruptions" above). Prior to welding in any area, the Contractor shall locate smoke detectors and shall request interruption of the fire alarm system. Subsequent to the interruption of the fire alarm system and prior to welding activities, the Contractor shall cover and protect smoke detectors until work is complete. Prior to expiration of each interruption of the system, the Contractor shall uncover the smoke detectors.
3. Electrical Service: The Contractor shall be responsible for verifying with the DEN Project Manager or representatives locations acceptable for accessing electrical power for welders and other electrical equipment feeders. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.
  - a. Temporary Hook-up: In addition to the requirements of paragraph "Temporary Power and Lighting for Construction" below, comply with the following:

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
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- 1) Provide wiring sized to accommodate full load of welding equipment, accounting for voltage drop.
  - 2) Provide appropriate NEMA twist-lock or ANSI receptacle for welder hook-up.
  - 3) 480V, 3 phase, 3 pole, 4-wire twist lock ground line.
  - 4) NEMA L16-20 or ANSI C73.87.
- b. The Contractor may not begin operation of the equipment prior to request for inspection by DEN representatives and acceptance of the installation.
  - c. Permanent installation of electrical branch circuiting for welding equipment shall be made in accordance with all Division 26 Specification Sections
4. Welding Practices: All standard safe welding practices must be followed, including but not limited to the following:
- a. Flash protection for surrounding areas.
  - b. Contractor fire extinguisher in area.
  - c. One person in each welding area solely designated as fire watch for each welder.
  - d. Protect all equipment, cable trays and contents, etc., in area.
  - e. Use fire blankets and other appropriate materials to confine sparks and molten metal from the welding, cutting, and/or grinding activities.
  - f. All welders shall have been qualified through welding tests in accordance with applicable welding code, such as but not limited to AWS, ASME, API, within one year prior to welding taking place. Evidence of qualification shall be through Welding Performance Qualification Records (WPQR).
  - g. All welder qualifications test shall be or shall have been administered and witnessed by an Independent Testing Agency (ITA), AWS Certified Welding Inspector (CWI).
  - h. If recertification of welders is required, delay costs and retesting costs shall be borne by the Contractor.
5. Grounding: Review with DEN representative's area of work prior to beginning work to ensure ground procedures do not induce undesirable charges in steel building system or other systems. This review should take place subsequent to the pre-work meeting. Do not ground to adjacent building systems, baggage system, hangers, or devices that support mechanical or electrical equipment.
- G. Temporary Power and Lighting for Construction:
1. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.
  2. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.
    - a. Comply with all requirements of NEC Article 590.
    - b. Flexible cords used for temporary power shall be listed in accordance with NEC Article 400, and rated for 'extra-hard' usage.
    - c. Provide an equipment grounding conductor with all temporary power circuits.
    - d. All temporary power distribution devices and equipment shall be listed and rated for the application.
    - e. Provide ground fault protection for personnel.
    - f. Temporary lighting fixtures shall be protected from physical damage.
- H. Cleaning Equipment and Spoils:
1. Discharge of water, liquids, or chemicals into a building sanitary sewer system or storm drainage systems is prohibited. The Contractor shall comply with all Federal, State, and Local requirements for disposal of chemicals and equipment wash water. The Contractor shall maintain and service all equipment in work areas and collect all

wash water, spoils and water from excavations in containers for discharge or removal off site.

- I. Vehicle Permitting for Tunnel and Basement Use:
  - 1. Electric carts require permitting. The Contractor shall provide at least one (1) electric cart for Contractor use during the work in the tunnel and basements of the buildings. Only electric or CNG powered trucks are allowed in the tunnel and basements of the buildings. Only electric or CNG trucks may be used and shall not be parked overnight or for long terms within the tunnel or basements. All vehicles require permitting. Permits may be acquired at the DEN Airport Security Office.
  
- J. Radio and Cell Phone Use:
  - 1. The Contractor shall have wireless communications in place prior to initiation of work in the tunnel or basements by use of cell phone and/or radio. Radio and cell phone coverage in the tunnels and basements varies in signal strength throughout the campus. An RF Application must be submitted for the Radio equipment intended for use at least 14 days prior to intended use. Include the following radio information:
    - a. Make
    - b. Model
    - c. Frequency
    - d. Effective Radiated Power (ERP)
  - 2. Contractors must receive an approval letter from the RF Systems Manager prior to use of the radio equipment on the DEN campus.
  
- K. Keys:
  - 1. The Contractor shall be required to contact DEN Maintenance Control to procure keys for access to all rooms having locks in order to gain access. Keys may be checked out at the beginning of each work shift by the Contractor and shall be returned to DEN Maintenance Control at the end of each work shift

## **1.05 COORDINATION**

- A. The Contractor will designate a contact person for coordination with the DEN Project Manager and airline tenants. The contact person shall have the authority to make decisions for the Contractor firm and shall have binding signatory power for changes in work. The contact person shall be on site at all times during work activity.
  
- B. No additional costs shall be considered for coordination activities throughout this project. The Contractor shall include in the Contractor's bid costs for coordination of all activities.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 DUST/PROTECTION BARRIERS**

- A. HVAC system containment. The Contractor shall submit to DEN Maintenance HVAC and Fire Alarm shutdown requests prior to modifications to the area of work for dust containment. The HVAC system shall be interrupted, re-routed, or blocked off to prevent dust from entering return or supply ducts.

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**TECHNICAL SPECIFICATIONS**  
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- B. Debris and Protection Barriers:. The Contractor shall construct code-approved and DEN-approved dust and debris barriers on both sides of walls and doors that are to be modified. Barriers shall be constructed to allow emergency ingress and egress to and from equipment and spaces. Barriers shall be constructed to allow continual uninterrupted function of building equipment and spaces.
1. Return all removed door hardware to DEN. Label each hardware set correlating the door number of the original hardware set. Coordinate with the DEN Project Manager for storage and return of hardware.

### **3.02 EQUIPMENT**

- A. Equipment: CNG-powered equipment is allowed within the buildings. No other fossil fuel equipment may be used within the buildings unless the equipment is directly vented to the building exterior.
- B. Electric: Electric powered equipment is acceptable in the Work area.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011400**

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**SECTION 011430****VEHICLE AND EQUIPMENT PERMITTING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Contractor shall comply with the Airport Security Program. Vehicle permits are required for all vehicles operating in the Secured Area. The DEN vehicle permit is required even if the vehicles are operating in the Secured Area but limited to above grade, outdoor activity. Vehicles or machinery operating within buildings shall be required to acquire a DEN emissions permit as well as a DEN vehicle permit.
- B. Special emphasis should be paid to Denver Municipal Airport System Rules and Regulations Part 20 – Airport Security Rules and Regulations and Part 130 – Operating Vehicles In The Secured Area" and Part 35 – Operations Infraction Accountability Program". The Denver Municipal Airport System Rules and Regulations can be found on the flydenver.com website.
1. All Work shall be accomplished in accordance with the most current version of FAA Advisory Circular (AC) 150/5370, "Operational Safety on Airports during Construction", 49 Code of Federal Regulations (CFR) Part 1542 and 14 CFR Part 139 except as modified herein.
  2. All Work shall be accomplished in accordance with the most current TSA Security Directives applicable to DEN, except as modified herein.
  3. Contractor may access runways, taxiways, and aprons only as necessary and only after establishing radio communications with Airport Operations through the DEN Inspector. No personnel or equipment will be allowed on the runways until radio contact has been made with Airport Operations and permission given.
  4. Access to the Movement Area will be limited in order to allow the maximum efficient movement of aircraft. As part of this limitation, the Contractor may be required to only use these areas late at night when there is less aircraft traffic
  5. Once admitted into the Secured Area, the Contractor shall proceed directly to the work location by way of the approved haul route. At no time shall a Contractor or any of its personnel enter onto a taxiway, runway, or ramp without proper clearance from the Airport Operations Manager or Assistant Airport Operations Manager. Contractors or individuals violating these requirements for driving in the Secured Area may be subject to fines, suspension, or permanent revocation of their driver authorization and/or Airport ID badge privileges.
  6. The Transportation Security Administration (TSA) requires that all operating airports be secured from the general public and has the authority to issue citations for violations of these requirements. It is the responsibility of the Airport to ensure all fences and gates are secure. If a Contractor's operations necessitate the frequent use of a particular gate, the Contractor shall place guards at the gate. Refer to 011420 – Security Requirements and SSI for details regarding the placement of guards.
- C. General Safety Regulations When in Aircraft Operations Areas May Include the Following:

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 011400 - VEHICLE EQUIPMENT AND PERMITTING**

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1. At all times, the Contractor shall coordinate its Work with the requirements of the Airport site and operations. All Work, movement of personnel, materials, supplies and equipment in areas used by aircraft shall be subject to regulations and restrictions established by the City. The Contractor shall take special precautions and be fully responsible for the prevention of damage to materials and equipment in the areas affected by the jet blast of taxiing aircraft. No work shall proceed until necessary protective devices are placed as required to protect the public, airport operations, property, and personnel from the hazards of the Work. The Contractor shall proceed with the Contractor's Work, including temporary work and storage of tools, machinery, and materials, to cause no interference with or hazards to the operation of the Airport.
  2. Landings, takeoffs, and taxiing shall take precedence over all Contractors' operations. In the event that the Contractor is notified that an emergency landing or a takeoff is imminent, the Contractor shall stop all operations immediately, regardless of the sequence of events in progress and shall immediately evacuate the Contractor's personnel and equipment from the runway and taxiway areas as directed.
  3. The Contractor shall remove its personnel and equipment to the distance specified below for the prevailing conditions:
    - a. For emergencies, the Contractor shall move all personnel and equipment as directed by Airport Operations or the DEN Project Manager.
    - b. At the end of a work day in areas where aircraft are operating, all equipment shall be moved to a location that is not less than 750 lineal feet measured from the near edge of the runway, taxiway or ramp area or to the location designated by the City.
  4. If the Contractor is asked to leave part of its work site to allow aircraft operation, the Contractor shall clean the area to allow safe aircraft movement. Cleaning may include sweeping the area to prevent damage to aircraft.
- D. Vehicle Permitting:
1. Refer to the Denver Municipal Airport System Rules and Regulations Part 20 – Airport Security Rules and Regulations and Part 130 – Operating Vehicles In The Secured Area" and Part 35 – Operations Infraction Accountability Program" for information regarding vehicle permitting. These Denver Municipal Airport System Rules and Regulations can be found on the flydenver.com website.
  2. Contractor should contact DEN Project Manager to submit Airfield Access requests for all vehicles and equipment not previously permitted. This includes vehicles and equipment for subcontractors. For additional information regarding permitting, the Contractor must contact DEN Security.
- E. Equipment Permitting
1. Fossil fuel powered equipment to be used in the interior of buildings and/or in basement/tunnel areas shall require inspection by DEN Maintenance and the Denver Fire Department.
    - a. Only CNG fossil fuel powered equipment may be used; gasoline powered, propane powered, or diesel-powered equipment will not be acceptable unless identified and operated per Section 011400 "Work Sequence and Constraints".

**1.03 SUBMITTALS**

- A. Refer to Section 03300 "Submittal Procedures" for submittal procedures
- B. Submit a copy of each vehicle permit and/or equipment and vehicle emissions permit a maximum of fourteen (14) days after receipt of permit.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.01 PERMITS**

- A. Vehicle permits shall not be issued prior to Notice to Proceed. The Contractor may, at the Contractor's own risk, submit required information prior to Notice to Proceed to the following:
  - 1. Airfield Access request: DEN Project Manager.
  - 2. Vehicle permit: DEN Airport Security.
  - 3. Equipment and vehicle emissions permit. DEN Project Manager or DEN Maintenance Group.

**3.02 SCHEDULE**

- A. The Contractor shall allow in the Contractor's schedule five (5) days for DEN review of submittals for permits. Testing of equipment and review by the Denver Fire Department shall be scheduled by the Contractor. By submitting information for permits, the Contractor certifies that equipment and vehicles comply with Contract documents and with all City, state and federal regulations including but not limited to emissions, licensing and safety requirements.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011430**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 011400 - VEHICLE EQUIPMENT AND PERMITTING**

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**SECTION 011810**  
**UTILITIES INTERFACE**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Various utilities are located within the limits of work in the Project area. The owners of these utilities may require that the Contractor work around their existing facilities until alterations, relocation, or abandonment have been completed. All known existing utilities are shown; however, the Contractor shall verify and satisfy itself that there are no other existing utilities that may not be shown.
- B. The owners of known utilities within the project area include, but are not limited to:
1. Xcel Energy Natural Gas
  2. Xcel Energy Elec. Services
  3. DEN Storm Water
  4. DEN Deicing Waste
  5. Denver Water Department
  6. FAA Duct Bank
  7. DEN Electrical Department
- C. The location and establishment of each construction vehicle crossing shall be at sites mutually agreed upon in writing by the Contractor and the owner of the utility.
- D. At the locations where the Contractor needs to establish a construction vehicle crossing over any of the operating pipelines, the furnishing and placing of a crossing shall be by the Contractor. The crossing shall allow the normal operation of the pipeline at all times unless specifically approved by DEN or the owner of the pipeline. Each crossing shall be adequately marked and signed for safe passage of vehicles over the crossing. Construction vehicles shall not be allowed to cross over operating pipelines at any place other than an established crossing.
- E. These utility locations are based upon information provided by the utility companies or previous construction contractors that were the basis for determining utility coordinates. The Contractor is responsible for confirming the accuracy of the provided coordinates with the utility owner.
- F. The Contractor shall control the Contractor's operations in order to avoid creating any obstacles for the utility owner's access for maintaining or operating their equipment.

**1.03 REFERENCE DOCUMENTS**

- A. Item P-153 "Controlled Low-Strength Material."

**1.04 REGULATORY REQUIREMENTS**

- A. The Contractor shall obtain and pay for all utility company permits, fees, and licenses necessary for the execution of this work. The Contractor shall give all notices and shall comply with all laws, ordinances, rules, and regulations of all authorities having jurisdiction.

**1.05 QUALITY CONTROL**

- A. When the Contractor performs any operations that will affect a utility owner, the Contractor shall give timely notice to the utility owner and the DEN Project Manager so that the Contractor's operations may be observed by the utility owner or their representative.

**1.06 WORK INCLUDED**

- A. The Work of this Section includes furnishing all materials, equipment, and labor necessary to provide utility crossings as required and as specified herein and subject to approval by the associated utility owner.
- B. North American Resources has a line passing through airport property. The Contractor shall contact the utility prior to beginning earthwork operations to ascertain any special requirements or conditions required to maintain and protect this service during construction activities.
- C. FAA Underground Duct lines: The FAA has duct lines passing under the site. The Contractor shall contact the FAA prior to beginning earthwork operations to ascertain any special requirements or conditions required to maintain this service during construction activities.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Suitable cover material shall be in accordance with Colorado Department of Transportation Standard Specifications. Wet, soft, or frozen material, asphalt chunks, or other deleterious substances shall not be used for cover.
- B. Aggregate for road base material shall consist of clean, sound and durable particles of crushed stone, crushed gravel or crushed slag, shall be free from coatings of clay, silt and organic matter, and shall contain no clay balls. Material shall conform to the State of Colorado Standard Specifications for Road and Bridge Construction Class 6 aggregate base unless otherwise specified.
- C. The materials for the load distribution system on top of the cover shall conform to the specification of the American Institute of Steel Construction, the American Institute of Timber Construction, or the American Concrete Institute, as applicable, depending upon the system agreed upon between the Contractor and utility owner.
- D. Materials for the sleeving of the pipelines shall be purchased by the utility owner at the Contractor's expense.
- E. Comply with utility backfill requirements for the use of flowable backfill in Item P-153 "Controlled Low-Strength Material".

**PART 3 - EXECUTION**

**3.01 NOTIFICATION OF UTILITIES FOR LOCATING AND POTHOLING**

- A. The Contractor shall verify the location of all utilities prior to any operations including physically uncovering the utility to verify location as required by the utility owner.
- B. The Contractor shall notify the Utility Notification Center of Colorado at (303) 534-6700 or 811, as a minimum for location of utilities.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011810**

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**TECHNICAL SPECIFICATIONS  
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SECTION 011810 – UTILITIES INTERFACE**

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**SECTION 012300****ALTERNATES****PART 1 - GENERALP****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for alternates.

**1.03 DEFINITIONS**

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
  2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

**1.04 PROCEDURES**

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Prior to the Contractor signing the Contract, the Owner will notify each party involved, in writing, of the status of each alternate, indicating if alternates have been accepted, rejected, or deferred for later consideration. The owner will also include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other Work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the Work described under each alternate.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 SCHEDULE OF ALTERNATES**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
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A. This contract does not include alternates. .

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 012300**

**SECTION 012510****SUBSTITUTIONS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. All material and equipment substitutions must comply with Title 4, Article 406: Substitution of Materials and Equipment in the General Contract Conditions, 2011 Edition.
- B. The Work specified in this Section consists of submitting form CM-09, Request for Substitution for the approval of a different material, equipment, or process than is described in the Contract Documents.
- C. If the substitution changes to the Scope of Work, Maximum Contract Cost, cost of the Work (if less than the Maximum Contract Cost), or Contract time, a Change Order is required.
- D. As-built drawings and specifications must include all substitutions even if a Change Order is not issued.

**1.03 REFERENCE DOCUMENTS**

- A. Form CM-09, Request for Substitution
- B. Section 013300 "Submittal Procedures"
- C. Section 013325 "Shop and Working Drawings, Product Data and Samples"

**1.04 QUALITY CONTROL**

- A. The substitution shall provide as a minimum, the same performance as specified.

**1.05 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. A completed Form CM-09 shall be submitted at least 60 days prior to when an order needs to be placed or a method needs to be changed.
- C. The submittal shall contain all the data required to be submitted for acceptance of the originally specified item or process, including, as appropriate:
  - 1. Detailed product data sheets for the specified items and the substitution.
  - 2. Samples and shop drawings of the substitution.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION****3.01 SUBSTITUTION PROCESS**

- A. Provide the information as required on Form CM-09.

**3.02 SUBSTITUTION REQUEST**

- A. The formal Request for Substitution will be evaluated by the DEN Project Manager and the Designer of Record based on the following criteria:
1. Compatibility with the rest of the project.
  2. Reliability, ease of use and maintenance.
  3. Both initial and long term cost.
  4. Schedule impact.
  5. The willingness of the Contractor to share equally in any cost savings.
  6. The ability of the item or process to meet all applicable governing regulations, rules, and laws along with funding agency requirements.
  7. The cost of evaluating the substitution.
- B. Based upon the above evaluation, the Senior Director of AIM Development will make a final determination of what is in the best interest of the City and either approve, disapprove or approve as noted the requested substitution.

**3.03 CONDITIONS**

- A. As a condition for submitting a Request for Substitution, the Contractor waives all rights to claim for extra costs or changes in the costs, schedule, Contract time or Scope of Work, other than those outlined in the request and approved by the Senior Director of AIM Development. The Contractor, by submitting a Request for Substitution, also accepts all liability for cost and scheduling impact on other contractors or the City due to the substitution.
- B. Included with the Request for Substitution shall be the following statement:
1. "The substitution being submitted is equal to or superior in all respects to the Contract-required item or process. All differences between the substitution and the Contract-required item or process are described in this request along with all required information, cost, and scheduling data."
- C. The statement shall be signed and dated by the Contractor's Superintendent.
- D. Replacement of Substitution Found to be Not Equal: The Contractor shall be responsible for all aspects and conditions of the substitution that are not clearly identified in the substitution submittal, and shall be liable for the appearance, function, performance or other aspects of the substitution that are found not to be equal to the originally specified item.
1. The Contractor shall incur all labor and costs associated with replacement of any substitution that is found to be not equal to the originally specified item or process and rejected by the DEN Project Manager.
  2. The replacement of any rejected substitution shall either be with the originally specified item or process, or a substitution approved by the DEN Project Manager.

**PART 4 - MEASUREMENT**

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**TECHNICAL SPECIFICATIONS  
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**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 012510**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 012910**  
**SCHEDULE OF VALUES**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions other Division 01 Specification Sections, and Related Requirements apply to this Section.

**1.02 RELATED REQUIREMENTS**

- A. The Work specified in this Section consists of preparing and submitting the Schedule of Values ("Schedule") as referenced in the General Conditions. Use the Project Specifications Table of Contents or Schedule of Prices and Quantities (Bid Tabs), if applicable, as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section. The Work also includes the preparing and submitting of updated copies of the Schedule if the Schedule is affected by change orders.
- B. A Schedule of Stored Material is a detailed cost breakdown for permanent materials that will be temporarily stored prior to their being installed and for which the Contractor seeks partial payments. The Schedule of Stored Material will be incorporated as a part of the Schedule of Values.
- C. Within 14 calendar days of issuance of the Notice to Proceed (NTP), the Contractor shall submit the Schedule of Values including the Schedule of Stored Material if applicable. The Schedule of Values and Schedule of Stored Material used to prepare the work/cost breakdown for the Schedule will be used for the Contractor's billings.
- D. D.Any Contract allowances shall be included in the Schedule. Expenditure of allowances shall be done using the Allowance Authorization form. Use of this form does not increase or decrease the Contract value.

**1.03 RELATED DOCUMENTS**

- A. Title 9 – Compensation of the General Contract Conditions, 2011 Edition
- B. Section 013300 "Submittal Procedures"
- C. Section 013325 "Shop and Working Drawings, Product Data and Samples".
- D. Form CM-89, Schedule of Values
- E. Form CM-91, Schedule of Values for Unit Price Contracts

**1.04 SUBMITTALS**

- A. The Schedule of Values shall be formally approved by the DEN Project Manager.
- B. The Schedule shall identify each item of work. Work items in the Schedule shall represent all Work and shall be referenced with the Technical Specifications section numbers, specification subparagraph, specification section title and the bid item number used for the Schedule of Prices and Quantities when applicable.

- C. Upon request by the City, the Contractor shall support values given with the data that will substantiate the correctness of the values.
- D. The Schedule will be utilized only as a basis for review of the Contractor's application for progress payment.

### **1.05 REVIEW AND RESUBMITTAL**

- A. If review by the DEN Project Manager indicates that changes to the Schedule are required, the Contractor shall revise and resubmit the Schedule.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 PREPARING SCHEDULE OF VALUES**

- A. Provide a breakdown of the Contract Price in enough detail to facilitate continued evaluation of Applications for Payment and progress reports.
- B. Breakdown of the items used in the Schedule shall include the following item costs. Ensure each item is complete:
  - 1. Delivered cost of product with applicable taxes paid.
  - 2. Total installation cost with overhead and profit.
  - 3. Breakdown costs of each lump sum item with a list of products and major operations for which the Contractor seeks to receive progress payments to recover the Contractor's costs for that bid item.
  - 4. Each unit price item as listed in the bid Schedule of Prices and Quantities shall list products and major operations for which the Contractor seeks to receive progress payments for that bid item.

### **3.02 PREPARING SCHEDULE OF STORED MATERIAL**

- A. The Contractor shall submit with the Schedule an indication of whether products will be stored on or off the work site. The Schedule of Stored Material shall show all quantities and types of products that will be stored.
- B. Material allowances consist of only the net cost of the product, the cost of delivery and unloading at the storage site, the cost of applicable sales taxes, and all discounts.
- C. In no case will the cost paid for a permanent material be greater than 90 percent of the Contract price for the Work in which they are included.

### **3.03 PAYMENT FOR STORED MATERIALS**

- A. Only materials that are described in the specifications and on the drawings will be considered permanent materials. Permanent materials are materials that will be left in the Work after the Contract is completed.
- B. Nothing in these specifications shall be interpreted as requiring the City to pay for stored materials. The DEN Project Manager shall decide on a case-by-case basis whether stored materials shall be paid for. No payment will be made for stored materials that have not been submitted and accepted.

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**TECHNICAL SPECIFICATIONS  
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- C. The Contractor must, at all times, store permanent materials in accordance with manufacturer's recommendations. Any material not properly stored will not be paid for. Amounts will be deducted from payments for any stored permanent material previously paid for and subsequently found to be improperly stored or not present, based upon a physical inventory of stored permanent material.
- D. Only the neat line quantity of material needed for the finished product may be paid for.
- E. All requests for stored permanent material payment must be accompanied by paid invoices clearly showing the quantity of permanent material, the type of permanent material and discounts or rebates and the net amount paid to the supplier along with a certificate stating that the permanent material is free of any liens or judgments preventing its use by the City.
- F. If the permanent material is stored outside the Denver area the Contractor must pay for the City representative's transportation and lodging to see the stored material as needed. Acceptable lodgings must, as a minimum, have a Mobil Travel Guide Rating Criteria® rating of Two-Star or the American Automobile Association Lodging Listing Requirements & Diamond Rating Guidelines® rating of Two Diamonds. The minimum transportation shall be by regularly scheduled commercial air carrier at coach rates. The DEN Project Manager will determine if an overnight stay is required.
- G. All permanent material stored off site, for which payment is being requested, must be insured and stored in bonded, insured warehouses. The Contractor shall provide proof of insurance for all material stored off site, and specific address and storage conditions of storage location.
- H. Any permanent material on which payment is requested must be in such a form that it cannot be used on work other than this Contract, or stored in a manner acceptable to the DEN Project Manager to ensure that the permanent material cannot be used on work other than this Contract.

**3.04 ALLOWANCE AUTHORIZATION AND PAYMENT**

- A. Contractor shall request written approval for expenditure of any Contract allowances PRIOR TO performing the Work involved. List work to be performed and estimated cost in the requesting correspondence.
- B. Original copies of all invoices and receipts must be submitted with the Allowance Authorization as part of the request for payment.
- C. Using the format provided by the City, the Contractor's request for payment of all Contract allowances shall be included in the Schedule of Values.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

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- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 012910**

**SECTION 013100****PROJECT MANAGEMENT AND COORDINATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative provisions for coordinating construction operations and coordination with other stakeholders and adjacent Contractors on the Project including,
1. Subcontractor's Acceptance Certification and Subcontractors List.
  2. General Coordination Procedures.
  3. Contract Administration Procedures.
  4. Current Project Management Information Systems (PMIS)
  5. Coordination drawings.
  6. Current DEN Asset Management Systems
  7. Requests for Information (RFIs).
- B. Related Requirements:
1. Section 011100, " Summary of Work" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
  2. Section 011400 "Work Sequence and Constraints" for shutdown requests and coordinating with airport operational activities.
  3. Section 011420 "Security Requirements and Sensitive Security Information (SSI)".
  4. Section 013210 "Schedule" for preparing and submitting Contractor's Construction Schedule.
  5. Section 013223 "Construction Layout, As-built and Quantity Surveys" for coordinating, survey activities and survey related record documents.
  6. Section 013300 "Submittal Procedures. "
  7. Section 013325 "Shop and Working Drawings, Product Data and Samples".
  8. Section 017720 "Contract Closeout" for coordinating closeout of the Contract.
  9. Section 017419 "Construction Waste Management and Recycling".
  10. DEN Building Information Modeling (BIM) Design Standards Manual (DSM)

**1.03 DEFINITIONS**

- A. RFI: Request from the DEN Contractor DEN Project Manager seeking information required by or clarifications of the Contract Documents.

**1.04 SUBMITTALS - SUBCONTRACTORS ACCEPTANCE CERTIFICATION AND  
SUBCONTRACTORS LIST**

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- A. To comply with Section 502.2 in the General Contract Conditions, 2011 Edition, the Contractor must complete and submit form CM-02 Subcontractor Acceptance Certification for each Subcontractor working on the project. Additionally, the Contractor must prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.
- B. Provide emergency contacts list to the DEN Project Manager prior to any site activities. List must contain project name, number, location, company name and address, name and title of emergency contacts in order and time and assigned responsibilities. Keep list current and accurate at all times. Include any specific security arrangements or special projects requirements.
- C. Within two (2) days of Notice to Proceed, the Contractor shall submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identifying individuals and their duties and responsibilities listing addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Providing names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
  1. Post copies of the accepted list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

**1.05 GENERAL COORDINATION PROCEDURES**

- A. Coordination with other Contractors:
  1. For details on coordinating with other Contractors, refer to Article 701 Cooperation with Other Work Forces, Article 702 Coordination of the Work, and Article 703 Coordination of Public Contact in the General Contract Conditions, 2011 Edition.
- B. Minimum cooperation requirements with other contractors include the following, unless directed by the DEN Project Manager in writing:
  1. Regular meetings, minimum weekly.
  2. Construction schedule coordination.
  3. Staging area and access planning (to include employee shuttle routes).
  4. Deliveries.
  5. Traffic control.
  6. When and where required or specified, the Contractor shall develop appropriate coordination drawings for use by interfacing adjacent parties using the Denver International Airport site.
- C. The following is a list that includes, but is not limited to, all of the contractors that will be working in the area of the project limits: TBD at time of contract award.
- D. Coordination with DEN entities shall include but is not limited to the following:
  1. Coordinate with Owner Contracted Communication Contractor.
  2. Coordinate with Utility Companies for utilities that are single sole source.
  3. Coordinate with Airport Security and DEN Maintenance for all security related services.
  4. Coordinate with DEN Life Safety Team for all issues related to fire alarm, fire protection systems in addition to compliance with all regulatory agencies.
  5. Coordinate all shutdowns and system interruptions in accordance with section 011400

"Work Sequence and Constraints."

## **1.06 CONTRACT ADMINISTRATION PROCEDURES**

- A. This Project will be administered in part using the current Project Management Information System (PMIS). Any processes necessary to properly administer the Contract and not included in the list below shall be addressed as acceptable to the DEN Project Manager. DEN Project Manager may modify the list below in serialized correspondence without constituting a change to the Contract. Administrative tools and processes shall not in any form waive any contractual or legal requirements of the law or the Contract. The Contractor shall attend all coordination meetings with the DEN Project Manager and the DEN Project Control Administrators to arrange for staff training, and technical support to facilitate the execution of electronic data management and control.
- B. Project Management Information Systems (PMIS): Oracle Unifier Enterprise Project Portfolio Manager (EPPM), or the Oracle Primavera P6.
- C. All submittals, RFIs, Pay Applications, Correspondence, change requests, and pricing proposals and settlement agreements shall be recorded and submitted using the current PMIS:
  - 1. The Contractor shall follow the specified PMIS Access Request Procedure and adhere to all user license conditions.
  - 2. The Contractor shall sign the Information Technology Agreement (ITA) to comply with the DEN computer system security requirements and any contractual obligation to the software and service providers for the current PMIS software
  - 3. DEN will train the Contractor's staff on the use of the PMIS.
  - 4. At a minimum, the Contractor shall provide computer hardware and software to meet the following requirements and to run the following programs, as required for the project:
    - a. Internet connectivity that provides the necessary high-speed connection to perform all activities indicated in this Contract.
    - b. Internet Explorer version 8 or higher.
    - c. Based on the project, a specific Java JRE application may be required, which can be downloaded from the Internet. If needed, the revision and update number will be provided at NTP.
    - d. Other files capability pre-approved by the DEN Project Manager or as required by the DEN BIM Execution Plan
    - e. Most current version of Revit, as per DEN requirements.

## **1.07 COORDINATION DRAWINGS**

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, BIM Design Standards Manual and BIM Project Execution Plan (BPXP), and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity. Coordination drawings will be the result of a Contractor driven Spatial Coordination effort as spelled out in the BPXP.
  - 1. Field verify all existing dimensions and any as-built dimensions, whether built by the Contractor or others, necessary to produce accurate coordination and working drawings.
  - 2. Content: Project-specific information, drawn accurately to a scale large enough to

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indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

- a. Use applicable Models/Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
  - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
  - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
  - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
  - f. Indicate required installation sequences.
  - g. Indicate dimensions shown on the Models/Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to DEN Project Manager indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Using software as in the BPXP, the Contractor shall coordinate these systems per floor or zone per BPXP, and as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
  2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
  3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire alarm, and electrical equipment.
  4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
  5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
  6. Mechanical and Plumbing Work: Show the following:
    - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    - c. Fire-rated enclosures around ductwork.
  7. Electrical Work: Show the following:
    - a. Runs of vertical and horizontal conduit.
    - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.

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- c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor control center locations.
    - d. Location of pull boxes and junction boxes dimensioned from column centerlines.
  - 8. Fire-Protection System: Show the following:
    - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
- C. Review: DEN Project Manager will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If DEN Project Manager determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, DEN Project Manager will so inform Contractor, who shall make changes as directed and resubmit.
- D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
  - 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings, unless approved otherwise by DEN Project Manager.
  - 2. File Preparation Format: Provided in the Project BIM Execution Plan operating in Microsoft Windows operating system.
  - 3. File Submittal Format: Submit or post coordination drawing files as required in the Project BIM Execution Plan.
  - 4. The submittal must be logged in accordance with the submittal procedure
  - 5. For Fire Protection system; provide shop drawing and design calculations as approved by the building department. Submit as-built drawings in format as outline in BXP.
  - 6. For all projects, receiving official variance from the BIM requirements not utilizing BIM, coordination drawings must be submitted in acceptable digital format shall be in an industry recognized 3D AutoCAD model.
  - 7. BIM File Incorporation: DEN Project Manager will incorporate Contractor's coordination drawing files into Building Information Model for Revit as established for Project.
    - a. Contractor shall lead three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect or other sub-consultants.
  - 8. DEN Project Manager will furnish Contractor one (1) set of digital data files of Models and/or Drawings for use in preparing coordination digital data files.
    - a. The Design consultants and Contractors and Sub Contractors acknowledge and represent the following Right Of Reliance regarding Electronic Models and/or Drawing deliverables:
      - 1) Models may be transferred for allowing the recipients to develop derivative models to develop the means and methods by which to construct the project.
      - 2) It must be clear that each party be able to rely on the fact that the model furnished by others "match the 2D Contract Documents or shop drawings in their equivalent state of development"

**1.08 COORDINATION WITH DEN ASSET MANAGEMENT SYSTEM:**

- A. The full intent is to produce comprehensive record documents integrating existing data in the form of digital files and models, reconciled to actual field conditions, modifications or

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additions facilities or components of existing facilities according to new Contract Documents, and to produce record documents that could be incorporated into DEN asset management system.

- B. Utilize the BIM to link all necessary data content to the model and follow the BPXP as collaboratively modified by the Contractor, Designer, and DEN BIM Administrators and approved by DEN Project Manager
- C. Provide the following information through the execution of the Contract for all elements and element types that DEN has designated as assets. The information shall include but is not limited to:
  - 1. Project title, number, project manager contact information, contractor and subcontractor contact information
  - 2. Pertaining shop drawings
  - 3. Operational Manuals and safety information, MSDS and cut sheets, and any pertinent technical information.
  - 4. Details of all components' maintenance procedures and requirements.
  - 5. Details of all applicable warranties including but not limited to; warranty providers, manufacturers information, warranty start and finish dates, contacts , bonding company name, consent of surety,
  - 6. Equipment location (by room number and location description or grid location format acceptable to DEN Project Manager, for civil projects), equipment make, model, serial number, and other asset information as outlined in the DEN BIM DSM
  - 7. List of all spare parts including but not limited to; equipment make and model, location, submittal number or link, and suppliers reordering information
  - 8. Commissioning results, acceptance criteria, test reports, and Tab reports

**1.09 REQUESTS FOR INFORMATION (RFIS)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI through the PMIS
  - 1. DEN Project Manager will distribute the RFIs to the proper entities.
  - 2. DEN Project Manager will coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's Work or work of subcontractors
- B. DEN Project Manager has the right to reject RFIs or those that do not contain proper information and required data to properly evaluate the request and respond in a timely manner.
- C. RFIs: Use PMIS to generate RFIs.
  - 1. Attachments shall be electronic files in Adobe Acrobat PDF format.
  - 2. Attachments include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- D. For projects not using Unifier to create the RFI, the RFI must include a detailed, legible description of item needing information or interpretation and the following:
  - 1. Project name.

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2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of DOR and DEN Project Manager.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
- E. DEN Project Manager will review each RFI, determine action required, and respond. RFIs received by DEN Project Manager after 1:00 p.m. will be considered as received the following working day. Direct responses by any entity other than DEN Project Manager shall not be binding to the City and County of Denver. E-mails, and verbal conversations must be followed by an official RFI or proper contractual vehicle before it is considered for any additional compensation or time impact to the project terms and conditions.
1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of DEN Project Manager's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  2. DEN Project Manager's action may include a request for additional information, in which case DEN Project Manager's time for response will date from time of receipt of additional information.
  3. DEN Project Manager's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Title 11 - Changes In the Work, Contract Price, or Contract Time in the General Contract Conditions, 2011 Edition as amended by Special Conditions.
  4. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify DEN Project Manager in writing within five (5) days of receipt of the RFI response or the time required by Title 11 - Changes In the Work, Contract Price, or Contract Time in the General Contract Conditions, 2011 Edition
- F. RFI Log: For projects not utilizing the PMIS application, prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. The log shall include but not limited to the following data:
1. Project name.

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2. Name and address of Contractor.
3. Name and address of DEN Project Manager.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date DEN Project Manager's response was received.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013100**

**SECTION 013119**  
**PROJECT MEETINGS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section requires the Contractor's Project Manager, Superintendent, and Quality Control representative to attend meetings scheduled by the DEN Project Manager for the collection and dissemination of information related to the subject Contract.
- B. The DEN Project Manager will prepare the minutes of each meeting and distribute them to each of the participants.

**1.03 REFERENCE DOCUMENTS**

- A. Form CM-01, Preconstruction Meeting Agenda
- B. Form CM-62, Construction Meeting Agenda/Minutes

**1.04 OTHER MEETINGS**

- A. The Contractor shall attend all other project related meetings as directed by the DEN Project Manager.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PRECONSTRUCTION MEETING**

- A. A Preconstruction Meeting will be scheduled by the DEN Project Manager after the Contract has been signed by all parties. The purpose of this meeting is to introduce the City's Representatives to their counterparts in the Contractor's organization and to establish lines of communication between these representatives and outline some Contract requirements. The Contractor's key personnel shall attend this meeting.
- B. The DEN Project Manager will distribute a notice of this meeting, along with an agenda of the subjects to be addressed. Refer to form CM-01, Preconstruction Meeting Agenda.
- C. The DEN Project Manager will explain and discuss the responsibilities and authorities of the City, the Designer of Record, and the DEN Project Manager's organization.
- D. The Contractor shall introduce the Contractor's key personnel, subcontractors, and representatives and briefly describe each person's responsibilities.

- E. The Contractor shall prepare a presentation with the items outlined in the CM-01, Preconstruction Meeting Agenda, at a minimum.
- F. Explanations provided by the DEN Project Manager will not amend, supersede, or alter the terms or meaning of any Contract document, and the Contractor shall not claim reliance on such explanations as a defense to any breach or failure by the Contractor to perform as specified in the Contract.

### **3.02 CONSTRUCTION PROGRESS MEETINGS**

- A. Progress meetings will be scheduled weekly and more often as necessary by the DEN Project Manager to promote the competent and timely execution of the Contract.
- B. The meetings will be held at the work site or at a location selected by the DEN Project Manager. Meetings will be chaired by the DEN Project Manager or the DEN Project Manager's representative.
- C. The Contractor's key personnel shall attend unless otherwise agreed by the DEN Project Manager.
- D. At a minimum, and as directed by the DEN Project Manager, the items detailed in CM-62, Construction Meeting Agenda/Minutes shall be addressed at each meeting. The items addressed in the meeting do not waive notification or submittal requirements as required elsewhere in the Contract.
- E. The DEN Project Manager will be responsible for publishing minutes of the meetings. Refer to form CM-62, Construction Agenda/Meeting Minutes.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013119**

**SECTION 013210  
SCHEDULE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section describes the procedures and requirements for scheduling and documenting the progress of the project:
  - 1. Design Schedules
  - 2. Preliminary Construction Schedule
  - 3. Initial Project Construction Schedule (IPS)
  - 4. Monthly Progress Schedule update
  - 5. As-built Schedule
  - 6. Special reports:
    - a. Weather impacts and mitigations
    - b. Unforeseen Conditions and mitigations
    - c. Recovery Schedule and alternatives

**1.03 REFERENCE DOCUMENTS**

- A. Article 1105 – Time Extensions in the General Contract Conditions, 2011 Edition.
- B. Section 011100 "Summary of Work"
- C. Section 011400 "Work Sequence and Constraints".
- D. Section 012910 "Schedule of Values".
- E. Section 013119 "Project Meetings"
- F. Section 013300 "Submittal Procedures"

**1.04 SUBMITTALS**

- A. Submit for City acceptance the following in accordance with Section 01 33 00 – Submittal Procedures:
  - 1. Project Scheduler Qualifications
  - 2. Design Schedules
  - 3. Preliminary Project Construction Schedule
  - 4. Initial Project Construction Schedule
  - 5. Monthly Progress Update Schedules
  - 6. Time Impact Analysis, when necessary

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**7. As-built Schedule****B. Scheduler/Scheduling Consultant Qualifications:**

1. A professional with a minimum of two (2) years of experience with scheduling design and construction projects similar in size and scope of work as this project using Oracle Primavera P6 software.
2. The scheduler shall have a comprehensive knowledge of Critical Path Method (CPM) scheduling principles and application.
3. The scheduler shall produce reports and diagrams within 24 hours of the DEN Project Manager's request and perform tasks, including but not limited to, the following:
  - a. Create, maintain and update the project design and construction schedule, including but not limited to baseline schedule management, cost and resource loading, time impact analysis, and schedule progress analysis.
  - b. Prepare monthly progress schedule updates, submit for review and incorporate the City's review comments into the schedule.
  - c. Coordinate the participation of qualified personnel to assist in the development of the initial design and construction schedule and updating of the monthly progress schedule.
  - d. Develop a Work Breakdown Schedule (WBS) to the appropriate level and be able to discuss verbally and in writing the applicability of the WBS.
  - e. Incorporate milestone dates for Owner-furnished products and deliverables.
  - f. Incorporate submittal requirements, procedures and time required for review of submittals and resubmittals.
  - g. Incorporate requirements for tests and inspections by independent testing and inspecting agencies.
  - h. Incorporate required meetings, such as Safety and Pre-work meetings.
  - i. Incorporate time required for Project closeout and Owner start-up procedures, including commissioning activities.
  - j. Adhere to contract specifications and requirements.

**C. Schedule Submittal Package Requirements:**

1. XER/XML file compatible with the latest version of Oracle Primavera P6
2. PLF File (if XER)
3. Narrative report including the following:
  - a. Prepare an accurate statement of the project's progress status to assist in decision making.
    - 1) Contract Milestone Dates, Current Schedule Dates
    - 2) Activities started or completed since last update
    - 3) Identify deviations from the baseline schedule and evaluate possible corrective actions.
    - 4) Logic Changes
    - 5) Critical Path Analysis / Schedule Risks
    - 6) Upcoming Activities that are impacted by or may impact stakeholders
    - 7) Change Order Activities
    - 8) Weather and other delays
  - b. A standard layout will be provided to the contractor.
4. PDF of the following:
  - a. Full Schedule View
  - b. Critical Path
  - c. Three Week Lookahead

**1.05 SCHEDULE PREPARATION REQUIREMENTS**

- A. Schedules should meet the requirements outlined in the “Schedule Approval Checklist” (Appendix 1) and the “Contractor Schedule Package” (Appendix 2). Contractor shall obtain current versions of Appendix 1 and 2 from the DEN Project Manager for use in developing the schedule. These requirements utilize the following documents as references for best practices:
1. AACE Recommended Practices (RP)
  2. USACE Project Schedules Regulation ER\_1-1-11
  3. DCMA 14-Point Schedule Assessment
- B. Projects regulated by the FAA must follow all FAA scheduling requirements, in addition to the requirements provided by DEN. In the event of a conflict between the DEN and FAA scheduling requirements, the more stringent requirement shall apply.
- C. The schedule shall satisfy, at minimum, the following criteria:
1. Prepare all Project Schedules utilizing the Critical Path Method (CPM) of network calculation to generate all schedule reporting.
  2. Show in the schedule, the proposed sequence to perform the work and dates contemplated for starting and completing the schedule activities.
  3. The scheduling of the entire project is required.
  4. Provide a schedule that is forward planning as well as a project monitoring tool
  5. Contractors, Design management personnel and DEN PMT/Stakeholders shall actively participate in its development.
  6. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate project schedule.
  7. The contractor shall keep the subcontractors and suppliers informed of the Project Construction Schedule to enable the subcontractors to plan and perform their work properly.
  8. All schedules shall comply with the City and County of Denver General Contract Conditions (GC)
  9. The schedule WBS will align with the approved schedule of values, as determined by the DEN Project Management Team, and contain, at minimum, the following milestone activities:
    - a. Start
    - b. Mobilization Complete
    - c. Substantial Completion
    - d. Final Completion
    - e. DEN reserves the right to request additional milestones to be included in all schedules as appropriate for each projects. The additional reporting requirements will be communicated by the Project Manager and PMO.
- D. Cost and Resource Loading of P6 Schedules
1. All schedules shall be cost loaded using the Lump Sum resource. Cost loading will align with the approved schedule of values, as determined by the DEN Project Management Team.
  2. Period Performance shall be stored for each schedule update provided to DEN.
  3. All schedules will be resource loaded with manhours by critical trade. Additional

resource loading requirement may be required by DEN PMT.

**E. Layout Requirements (.PLF)**

1. Project Layout Files (.PLF) will be created to standardize the information provided to DEN from the schedule, and the .PLF will be used to create the PDF schedule documents as part of the submittal package.
2. All PDF's will contain both the table and the Gantt Chart, and will be scaled to fit timescale to 1 page wide. Additionally, the following information will be displayed:
  - a. Table will contain: Activity ID, Activity Name, Baseline Start, Baseline Finish, Original Duration, Start, Finish, Duration at Completion, Finish Variance, Total Float
  - b. Gantt Chart:
    - 1) Timescale shall show the entire project schedule without cutting off any data
    - 2) In the Bar Options, the following Bars shall be displayed: Remaining Level of Effort, Actual Level of Effort, Primary Baseline, Actual Work, Remaining Work, Critical Remaining, Start Constraint, Finish Constraint, Milestone, Summary, Negative Float Bar. Activity names will be included as the bar label.
    - 3) In the Bar Chart Options, "Show Relationships" shall be checked.
    - 4) In the print layout, the header shall include at minimum the data date, current date, filter, project name, schedule update version, and contractor. The footer shall contain at minimum the legend and page count.
3. Full Schedule View will not be filtered, all activities will be shown.
4. Critical Path view will be filtered to show only the critical Activities.
5. Three Week Lookahead View will be filtered to show activities completed in the past week, or activities that are in progress or not started for the next three weeks.
6. Additional information or reports may be requested at the DEN Project Management Team's discretion, including but not limited to cash flow, manhours graph, earned value, period performance.

**F. Withholdings / Payment Rejection**

1. Failure to meet the requirements of this Section may result in the disapproval of the schedules or updates and subsequent rejection of payment requests until requirements are met.
2. If the DEN Project Manager directs schedule revisions and those revisions have not been included in subsequent Project Schedule revisions or updates, the DEN Project Manager may withhold 10 percent of pay request amount for each payment period until such revisions to the project schedule have been made.

**1.06 COORDINATION**

- A. Pre-scheduling Conference: Schedule conference at Pre-Construction meeting to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to setting up the Preliminary Project Design and / or Construction Schedule and Initial Project Construction Schedule, including, but not limited to, the following:
1. Verify availability of qualified personnel needed to develop and update schedule.
  2. Review content and format for reports.
  3. Discuss constraints, including phasing, area separations, interim milestones, stakeholder requirements and partial Owner occupancy.

4. Review milestone dates for Owner-furnished products and deliverables.
  5. Review submittal requirements and procedures.
  6. Review time required for review of submittals and resubmittals.
  7. Review time required for Shutdown request and approval.
  8. Review requirements for tests and inspections by independent testing and inspecting agencies.
  9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
  10. Review procedures for updating schedule.
  11. Review requirements for content and input of direct man-hour resources in activities.
  12. Review requirements for cost loading of activities.
  13. Coordinate Initial Project Construction Schedule with the Schedule of Values and Schedule Template.
  14. Secure time commitments for performing critical elements of the Work from entities involved.
- B. Construction Coordination: If there are activities in the schedule that are impacted by DEN, DOR, other contractors or other stakeholders, a periodic meeting will be set up with all stakeholders to evaluate the schedule and confirm dates for activities outside of the contractor's control. The contractor will be responsible for providing the most up to date schedule to all attendees in PDF format, in accordance with Section 1.3.C Submittals of Technical Specifications 013210 Schedule. The frequency of this meeting will be at the discretion of the Project Management Team.
- C. Delays, Recovery Schedules, and Requests for Extension: If the project is experiencing delays, a meeting will be set up with the designer, engineer, contractor, the PMT, and DEN Project Controls to evaluate the package provided by the contractor. The designer / contractor will be responsible for providing the most up to date schedule to all attendees in PDF format in advance of any meetings, in accordance with Section 1.3.C Submittals of Technical Specifications 013210 Schedule, as well as any supplemental information that supports requests for re-sequencing, extensions etc. Additionally, the contractor will provide all required information from sections 3.10, 3.11, and 3.12 of Technical Specifications 013210 Schedule. If DEN determines that additional coordination is required, a periodic meeting will be set up at the discretion of the Project Management Team.

## **PART 2 - PRODUCTS**

### **2.01 SOFTWARE**

- A. DEN Default Software:
1. DEN shall use the latest release of Oracle Primavera P6 for all city scheduling needs.
- B. Designer / Contractor Software:
1. Scheduling software used by the designer / contractor shall be compatible with the latest release of Oracle Primavera P6.
  2. The software and any support agreements shall be purchased at the designer's / contractor's expense from a vendor of the contractor's choosing.
  3. The City will not provide training or support services for designer / contractor purchased software.

**C. Oracle Primavera P6 Software Settings:**

1. The following settings are mandatory and required in all schedule submissions to the City. Submittals that do not meet these criteria will be rejected:
  - a. All schedules will only contain project data at the Project Level and not at the Global or EPS level. Project data includes but is not limited to calendars, risks, OBS, activity codes and user defined fields.
  - b. Time Period Administration Preferences shall remain the default “8.0 hour/day, 40 hour/week, 172 hour/month, 2000 hour/year”. Set Calendar Work Hours/Day to 8.0-hour days.
  - c. Set Schedule Option for defining Critical Activities to “Longest Path”
  - d. Set up cost loading using single lump sum resource. The resource should be named “Lump Sum”. The Price/Unit shall be \$1/hour, Default Units/Time shall be 8h/d”, and settings “Auto Compute Actuals” and “Calculate Cost from Units” selected.
  - e. Activity ID’s shall not exceed 10 characters.
  - f. Activity Names shall not exceed 30 characters, and will start with Verb/Action, followed by the work area, followed by additional information.

**PART 3 - EXECUTION****3.01 PRELIMINARY PROJECT DESIGN / CONSTRUCTION SCHEDULE SUBMISSION****A. General**

1. Within ten (10) days after the issuance of Notice to Proceed (NTP), submit the Preliminary Project Design / Construction Schedule:
  - a. If contract time is greater than 120 calendar days, submit the Schedule defining the planned operations detailed, at a minimum, for the first sixty (60) calendar days of the project for acceptance.
  - b. If contract time is shorter than 120 calendar days. submit the Schedule defining the planned operations detailed for the full contract term for acceptance.
  - c. It shall be early start and late finish constrained and logically tied as specified.
2. The Preliminary Project Design / Construction Schedule shall form the basis for the Initial Design / Project Construction Schedule specified herein and shall include all the required plan and program preparations, submissions and approvals identified in the contract. For example, Design Work Plan, Design Submittal dates and review times, Quality Control Plan, Site-specific Safety Plan, and Environmental Protection Plan, etc.
3. The DEN Project Management Team will respond within 14 days to the Preliminary Schedule submittal with either acceptance or direction to revise and resubmit.
4. In lieu of the Preliminary Project Design / Construction Schedule, the Designer / Contractor may, at the Designer’s / Contractor’s own discretion, submit the Initial Project Design / Construction Schedule at the Design Kick-Off or Preconstruction Meeting.
  - a. If the Initial Project Design / Construction Schedule is submitted in lieu of the Preliminary Project Design / Construction Schedule, the DEN Project Management Team will respond within thirty (30) days with acceptance or direction to revise and resubmission is required within ten (10) days.
5. Acceptance of Preliminary Project Construction Schedule will not constitute approval of Schedule of Values.

**3.02 INITIAL PROJECT DESIGN / CONSTRUCTION SCHEDULE SUBMISSION**

**A. General**

1. Submit the Initial Project Design / Construction Schedule for acceptance within fourteen (14) days after issuance of NTP.
2. The schedule shall demonstrate a reasonable and realistic sequence of activities which represent the Work through the entire contract performance period.
3. The DEN Project Manager will respond within 14 days with acceptance or direction to revise and resubmit.
4. The acceptance of the schedule is for general conformity to the Contract requirements and shall not constitute any relief of any Contract requirements.
5. Upon acceptance from the DEN Project Manager and DEN Project Controls, the Initial Project Design / Construction Schedule shall become the Baseline Schedule for the duration of the project.
6. The Baseline Project Design / Construction Schedule may be changed when one or more of the following events occur:
  - a. When a Change Order significantly affects the contract completion date or sequence of work.
  - b. When the Designer / Contractor elects to change the sequence or duration of work items affecting the critical path resulting in a major change that requires DEN approval.
  - c. When the City directs a change that affects a milestone dates specified in the Special Conditions or alters the length of a critical path.
7. Failure to include any work item required for performance of this Contract shall not excuse the Designer / Contractor from completing all Work within applicable completion dates, regardless of the City's acceptance of the schedule.
8. Failure of the designer / contractor to have an Initial Project Design / Construction Schedule accepted by DEN Project Manager will be considered cause for withholding progress payment.
9. This submittal shall include all package requirements included in section 1.3.C of this Technical Specifications 013210 Schedule document.

**3.03 MONTHLY PROGRESS DESIGN / CONSTRUCTION SCHEDULE UPDATES****A. General**

1. The Designer / Contractor shall submit a monthly progress schedule at the end of each month following the issuance of NTP, prior to approval of the invoice.
2. At the end of each month, the Contractor and DEN Project Manager shall agree on the progress of the work and the Contractor shall update the Construction Schedule accordingly.
3. This review does not constitute an acceptance of the Monthly Progress Schedule update and shall not be used for the purpose of modifying the accepted Baseline Project Design / Construction Schedule.
4. Failure of the Designer / Contractor to have a Monthly Progress Design / Construction Schedule accepted by the DEN Project Manager will be considered cause for withholding progress payment per Article 306 - Working Hours and Schedules and Article 909 - Additional Withholding of Progress Payments of the General Contract Conditions, 2011 Edition.
5. The Designer's / Contractor's monthly progress schedule shall include all package requirements included in section 1.3.C of this Technical Specifications 013210 Schedule document.

6. The Contractor shall provide the DEN Project Manager an electronic copy prior to and a minimum of four (4) hard copies of the Contractor's Three (3) Week Look-Ahead Schedule for review at the DEN Project Manager's weekly progress meeting.

### **3.04 AS-BUILT CONSTRUCTION SCHEDULE:**

#### **A. General**

1. After all Contract Work items are complete, the contractor shall submit an as-built Project Construction Schedule that reflects the actual sequence of construction activities, includes all change order scope of work changes and shows actual start and finish dates for all work items and milestones for acceptance by the DEN Project Manager.
2. The basis for the As-built Construction schedule will be the approved Monthly Progress Schedules.

### **3.05 RECOVERY SCHEDULE**

#### **A. General**

1. When a monthly progress schedule update indicates the Work is behind the current approved schedule, the Designer / Contractor submits a separate Recovery Schedule indicating the means by which the Designer / Contractor intends to regain compliance with the schedule.
2. No additional costs will be allowed if such expediting measures are necessary to meet the agreed completion date or dates except as provided elsewhere in the Contract Documents.
3. If the early finish date for any work item or the substantial completion date does not fall within the Contract Duration, the sequence of work or duration shall be revised by the Designer / Contractor through concurrent operations, additional manpower, additional shifts or overtime, additional equipment, or alternative construction methods until the schedule produced indicates that all significant contract completion dates, occupancy dates and milestone dates will be met.
4. Provide a narrative indicating changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
5. The narrative shall be submitted in accordance with Article 1105 – Time Extensions in the General Contract Conditions, 2011 Edition.

### **3.06 REQUEST FOR TIME EXTENSION**

#### **A. General:**

1. Provide a justification of delay to the DEN Project Manager, in accordance with the Contract provisions and clauses, for approval within 10 days of a delay occurring.
2. Prepare a time impact analysis for each DEN Change Directive, Change Notice and Contractor's Change Request to justify time extensions.
3. Added work by the City does not necessarily entitle a Designer / Contractor to a Time Extension, unless the Designer / Contractor can prove that this new added scope impacts the current critical path without manipulating any of the logic and relationships in the most recent and approved schedule.
4. The City may reject any Time Extension Request that does not include a detailed and a clear time impact analysis that shows direct impact to the most current critical path along with a detailed productivity rate calculation to justify the requested time to

execute such added work.

5. If the Designer / Contractor is granted an extension of time for completion of any milestone or contract completion date under the provisions of the Contract, the determination of the total number of extended days will be based upon the current analysis of the schedule and upon all data relevant to the extension. Such data shall be incorporated into the next monthly update of the schedule.
6. The Designer / Contractor acknowledges and agrees that delays in work items that, according to schedule analysis, do not affect any milestone dates or the Contract completion date shown on the CPM Network Schedule at the time of the delay will not be the basis for a Contract extension.

**B. Justification of Delay**

1. Provide a description of the event(s) that caused the delay and/or impact to the work. As part of the description, identify the schedule activities impacted.
2. Show that the event that caused the delay/impact was the responsibility of the City.
3. Provide a time impact analysis that demonstrates the effects of the delay or impact on the project completion date or interim completion dates.
4. Multiple impacts shall be evaluated chronologically; each with its own justification of delay. With multiple impacts, consider concurrency of delay.
5. A time extension and the schedule fragment become part of the project schedule and future schedule updates upon approval by DEN Project Controls.

**C. Time Impact Analysis (Prospective Analysis)**

1. Prepare a time impact analysis for City approval based on industry standard AACE 52R-06. Use a copy of the last approved schedule prior to the first day of the impact or delay for the time impact analysis.
2. If DEN Project Controls determines the time frame between the last approved schedule and the first day of impact is too great, prepare an interim updated schedule to perform the time impact analysis.
3. Unless approved by the DEN Project Controls, no other changes will be incorporated into the schedule being used to justify the time impact.

**D. Fragmentary Network (FragNet)**

1. Prepare a proposed fragment for time impact analysis. The proposed fragment shall sequence new activities into the project schedule to demonstrate the influence of the delay or impact to the project's contractual dates.
2. Clearly show how the proposed fragment shall be tied into the project schedule, including the predecessors and successors to the fragment activities.
3. Obtain City approval of the proposed fragment before incorporating it into the project schedule.

**E. Time Extension**

1. Time extensions will not be granted until after the City has approved the Justification of Delay, including the time impact analysis.
2. No time extension will be granted unless the delay consumes the available Project Float and extends the projected finish date ("Substantial Completion" milestone) beyond the Contract Duration.
3. The time extension will be in calendar days.

4. Actual delays that the City determines are caused by the Designer's / Contractor's own actions and result in a calculated schedule delay will not be a cause for an extension to the performance period, completion date, or interim milestone date.

F. Impact to Early Completion Schedule

1. No extended overhead will be paid for delay prior to the original Contract Substantial Completion date.

### **3.07 FAILURE TO ACHIEVE PROGRESS**

A. General:

1. If the progress falls behind the approved baseline project schedule for reasons other than those that are excusable within the terms of the Contract, the City may require submittal of a written recovery plan for approval.
2. The plan shall detail how progress shall be recovered, including which activities will be accelerated by adding additional crews, longer work hours, extra work days, etc.

B. Artificially Improving Progress

1. Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited.
2. Indicate assumptions made and the basis for logic, constraint, duration, and calendar changes used in the creation of the recovery plan.
3. Additional resources, manpower, and daily and weekly work hour changes proposed shall be evident at the work site and documented in the daily report along with the Schedule Narrative Report.

C. Failure to Perform

1. Failure to perform work and maintain progress in accordance with the supplemental recovery plan may result in an interim and final unsatisfactory performance rating and/or may result in Non-Conformance Report for corrective action directed by DEN Project Controls pursuant to other Contract provisions.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013210**

**SECTION 013223.11****CONSTRUCTION LAYOUT AND AS-BUILT SURVEYS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section covers Denver International Airport (DEN) procedures and accuracy requirements for survey services for construction layout, and as-built.
- B. Before commencing any field surveys on DEN property, the Contractor must coordinate a pre-survey preparation activities meeting. This meeting is to be arranged through the DEN Project Manager's Office with the attendance of the Contractor and the DEN Survey Section. The Contractor is responsible for obtaining DEN related survey guidance, Access to DEN survey network, Primary Control, projection parameters, and training materials from the DEN Survey at the pre-survey meeting and/or prior to beginning any survey work.
  - 1. Project Checklist, provided as part of this Specification, must be reviewed at the pre-survey preparation activities meeting. (Refer to Article 1.11.)

**1.03 REFERENCE DOCUMENTS:**

- A. Section 013223.15 "Survey Information".
- B. Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples".
- C. Latest version of Federal Aviation Administration Advisory Circular 150/5300
- D. Latest Version of DEN BIM DSM (Design Standards Manual)
- E. Latest Version of Colorado Department of Transportation (CDOT) Survey Manual.
- F. Latest Version of Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Survey Statement of Work (SSOW):
  - 1. The Contractor must develop a complete SSOW and submit it to the DEN Project Manager. The SSOW is the Contractor's written description of the Contractor's methodology for surveying services that must be provided as part of the Project, including specific features that must be surveyed, action items, timelines necessary airport resources and general information.
  - 2. SSOW must be submitted by the Contractor prior to commencement of any survey or

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 013223.11 – CONSTRUCTION LAYOUT  
AND AS-BUILT SURVEY**

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**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

- layout work on the site.
3. The SSOW will be accepted by the DEN Project Manager.
  4. Under no circumstances must the Contractor begin work until the SSOW has been accepted.
- C. Survey and Quality Control Plan (SQCP):
1. The Contractor must develop a complete SQCP and submit it to the DEN Project Manager. The SQCP is the Contractor's written description detailing the Contractor's methodologies for data collection, data safeguarding and quality assurance. Provide insight on how the Contractor must completely check all data to ensure it is complete, reliable, and accurate. Identify data safeguards used to protect the sensitive and safety critical data. Utilize a checklist based quality control process with definable and repeatable standards for each element ensuring consistency of work between different personnel within an organization. Submit the plan in a non-editable PDF.
  2. SQCP must be submitted by the Contractor prior to commencement of any survey or layout work on the site.
  3. The SQCP will be accepted by the DEN Project Manager.
  4. Under no circumstances must the Contractor begin work until the SQCP has been accepted.
- D. Weekly Project Status Report:
1. Contractor must submit a project status report in compliance with FAA AC 150/5300-18B to the DEN Project Manager every Monday by 2:00 P.M. Mountain Time, from the date of the task order until the date of Substantial Completion
  2. The Weekly Project Status Report must use format from AC 150/5300-18B
- E. Final Project Survey Report:
1. The Final Project Survey Report, must use format from AC 150/5300-18B
  2. Final Project Survey Report must be stamped and wet signed by a current Colorado Registered Professional Land Surveyor.
- F. SURVEY DELIVERABLES:
1. Contractor must submit all of the following deliverables.
  2. All raw files: GPS and Levels that is compatible with Trimble Business Center.
  3. If combining x, y from GPS and z from Levels, provide field notes and data that shows where this data came from to verify values. The GPS point numbers must match to the Level descriptions.
  4. As-built or as-constructed survey submittals must need to be in both Portable Document Format (PDF) and in AutoCAD Civil 3D. Refer to current and criteria document for direction on PDF production.
  5. All copies of original pages of field notes or electronic field notes must be in (PDF).
  6. Scanned copies of all original field notebooks used for this Project must be submitted at the end of Contract.
  7. All as-built points files must be in either CSV or TXT format.
  8. All CAD drawings must be in current approved Autodesk Civil 3D format.
    - a. CAD layers are specified in DEN BIM Design Standards Manual
    - b. DEN must provide the Autodesk Civil 3D drawing template.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 013223.11 – CONSTRUCTION LAYOUT**  
**AND AS-BUILT SURVEY**

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**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
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9. The as-built survey must follow the most recent Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey for all sections, as far as they are applicable to the scope of work for the project and site in question.
10. Documentation in accordance with “Table A, Optional Survey Responsibilities and Specifications” (Refer to Article 1.11.) is filled out with the required content to be submitted.
11. Hard copy of all documentation stamped and wet signature by licensed PLS responsible for the work.

**1.05 QUALITY REQUIREMENTS**

- A. Contractor – Company contracted to perform survey work under the direct supervision of a Colorado Registered Professional Land Surveyor with current FAA “Idle Certification”
- B. Subsurface Utilities Engineering (SUE): Refer to Section 011810 "Utilities Interface" for information related to underground utilities.
- C. Surveying accuracies and tolerances in control surveys, construction layouts: See CDOT Survey Manual for acceptable tolerances.

**1.06 DEN SITE SURVEY REQUIREMENTS**

- A. A site survey, construction survey, or construction as-built survey providing horizontal location and level information of surface features and both above and below ground services and utilities must be completed. This must also be annotated with information (where applicable) relating to the size, direction of and material type.
  1. When collecting utilities, Contractor must be responsible to have all exposed and installed utilities surveyed prior to being covered. If Contractor fails to survey utilities, DEN Project Manager can have the Contractor uncover the utilities so they can be surveyed.
  2. Any temporary works that remain at the completion of the project must also be surveyed.
  3. FAA and DEN Survey codes must be provided by The DEN Project Manager via DEN Survey or Designee and must be used throughout the project by Contractor for as surveyed features.
  4. The most current DEN Civil 3D template must be provided by The DEN Project Manager via the DEN BIM team. All DEN BIM requirements must be met.

**1.07 DEN ALIGNMENT MONUMENTATION**

- A. Alignment monuments must be set at their corresponding coordinates as shown on the monumentation sheet of the Alignment Plans. When monumenting the Alignment, the Contractor must verify that the latest set of Alignment plans are being used. After the Alignment monument locations are staked in the field, any necessary utility locates should be called for prior to setting the monument.
- B. All Alignment monuments set must be established within the Minimum Horizontal Accuracy Tolerance as required in this chapter for a CDOT Class B – Secondary survey.
- C. Alignment monuments must be set at the locations as shown on the Alignment Plans, which include the following locations:
  1. All angle points or changes of directions.

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2. At the beginning and ending of curves.
  3. At the points of change of direction or changes of radius of any boundary defined by circular arcs.
  4. Not to exceed 1,400 feet apart along any straight boundary line.
  5. Any other points as approved by the Survey Coordinator due to field conditions encountered during setting of the Alignment monumentation.
- D. Alignment monuments must have a witness post installed within 2 ft and facing the monument, or as accepted by DEN Survey. For setting easement monuments, the witness post requirement may be waived by DEN Survey.
- E. Use Orange Carsonite witness post:
- F. All Alignment monument caps set in the field must be stamped with the following:
1. DEN Project Code number
  2. Point number as shown on the Right of Way Plans
  3. Colorado PLS number setting the monument
- G. All Alignment monuments set in the field must be shown on the Final set of Alignment Plans in accordance with the CDOT Right of Way Manual, Chapter 2 – ROW Plans. The Colorado PLS who is in responsible charge for setting the Alignment monuments must stamp her/his number on the monument cap, and must certify on the Alignment Plans to setting of the Alignment monuments in the field.
- H. The Contractor in responsible charge of the Alignment Plans and the Contractor in responsible charge of setting the Alignment monuments in the field might not be the same individual. Therefore, care must be taken to ensure any monuments set in the field at locations different than that shown on the Alignment Plans are communicated to the Alignment plans section, and the final Alignment Plans are corrected to show these new monument locations and descriptions prior to submitting the plans to DEN Survey.
- I. Alignment monuments, witness posts, and monument box materials must be furnished by Contractor.

**1.08 FEATURES TO BE RECORDED**

- A. Surface and Above Ground Features: The survey of surface features must include, but is not limited to:
1. Structures and Surfaces – paths, driveways, retaining walls, slabs/paved areas, significant structural footings (plinths etc.), poles/ floodlighting.
  2. Drainage Structures – headwalls, open drains, grated drains, culverts.
  3. Roads – edge of pavement, curbs, shoulders, line-marking, bridges, road furniture (NOTE – the top back and bottom face of curb, and all water channels must be surveyed and recorded).
  4. Buildings – footprints, awnings, overhangs, columns, external fixtures (stairs, ramps, plant, etc.).
  5. Fences and Gates – AOA, security, general fencing, gates and handrails.
  6. Aircraft Pavements and Movement Area Structures – finished surfaces, pavement markings, airfield markers/signage/ navigational aids, PLB and other aeronautical infrastructure;

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7. Topographical Features – general topography, embankments, earthworks platforms and surcharge.
  8. Vegetation – gardens, significant trees (>0.2' trunk diameter, decorative shrubs), vegetation stands, riparian zones.
  9. Signage – road, airfield, parking, advertising, other general signage.
  10. Survey Marks – survey control points used, any settlement plates/ monitoring points placed during works.
  11. Airfield panel corner elevations must be derived from digital levels.
- B. Services and Utilities - Prior to any backfilling or covering, information on all underground services must be obtained and documented according to DEN's modified ASCE-SUE Standards, including but not limited to:
1. Electrical (LV and HV) – top of conduit every fifty feet including horizontal and vertical bends, cables and conduits, pits/ manholes and chambers, HV cable joints, earth points and earth mats, substations/ transformers and surrounding pad, pillars, cabinets and switchboards, top of conduits.
  2. Fuel Control – top of conduit every fifty feet including horizontal and vertical bends, cables and conduits, pits/ manholes and chambers, cabinets, emergency shut-off points.
  3. Communications - top of conduit every fifty feet including horizontal and vertical bends, fiber optic, microducts, comms cables and conduits, pits/ manholes and chambers, top of conduit casing/housing.
  4. Drainage – top of pipes at fifty-foot intervals and at every vertical and horizontal bend, inspection openings, pits/ manholes and chambers, roof water drainage (downpipes, small pits/ grates).
  5. Fuel – top of pipes every fifty feet including horizontal and vertical bends, all weld points with weld numbers documented in the point description and in the field notes, pits/ manholes and chambers, valves, hydrants, earth points, test points.
  6. Sewer (note whether gravity or force main) – top of pipes every fifty feet including horizontal and vertical bends, pipes, pipe inverts, pipe outflows, inspection openings, pits/ manholes and chambers, vent pipes, pump stations and associated components.
  7. Water (differentiate between potable and recycled) – top of pipes every fifty feet including horizontal and vertical bends, pits/ manholes and chambers, valves (and type), meters, taps, hydrants, tanks, pumps, irrigation control.
  8. Compressed Air – top of pipes every fifty feet including horizontal and vertical bends, hoses and other fixtures.
  9. Natural Gas / Petroleum– top of pipes every fifty feet including horizontal and vertical bends, valves, tanks, meters.
- C. Sufficient points must be recorded to ensure that the extremities of all surface features, structures and footings are clearly defined and all bends, intersections, and changes of gradient are accurately recorded. The distance between points of location should generally be about 50 feet and must not exceed 100 feet. All curves must be accurately defined using a minimum of three points (two tangent points and one midpoint).
- D. Where actual positions of linear features deviate from a straight line, sufficient additional points of location must be provided to define the deviation – horizontal and/or vertical change in directions.
- E. For systems, utilities, and features not identified herein, refer to PM for direction on capture

requirements

### 1.09 SURVEY METHODOLOGY – SERVICES AND UNDERGROUND FEATURES

- A. Sufficient points must be recorded to ensure that the extremities of all pits, manholes, and any other features related to the service are clearly defined and all bends, joints, intersections, changes of gradient, and fittings on or along the service, pipe or conduit are accurately recorded. All curves must be accurately defined using a minimum of three points (two tangent points and one midpoint). Where actual positions of linear features deviate from a straight line, sufficient additional points of location must be provided to define the deviation – horizontal and/or vertical change of directions.
- B. The maximum distance between points of location along services must not exceed 50 feet. Horizontal and vertical locations must be surveyed on the top of the utility and must be labeled as “top”. Inverts measurements must also be taken in manholes and must be labeled.
- C. The Contractor must record and annotate all services and utilities with information relating to the size, direction of and material type. The Contractor must record and clearly differentiate between the communication service providers and DEN and/or FAA communications infrastructure.
- D. The Contractor must record the size and orientation of all grates, pits and manholes. Grates and pits must be recorded using a minimum of three corner or edge points. Pit/ manhole chambers only need to be located and where the extents of the chamber extend past the extremities of the pit at surface level. In all instances, any thrust blocks or concrete cover/ protection over services must be located, showing depth.

### 1.10 EXISTING FEATURES AND SERVICES

- A. Existing Services: where the existence of services and other features on the site of the Work and the Work exposes or interacts with these existing services, the Contractor must locate and record the details of all such features and services.
- B. Tunnel Boring: The Contractor must provide records (logs, profiles etc.) relating to all tunnel boring undertaken as part of the Project. Where appropriate this information must be incorporated into the as-built site survey. Where the contract drawings do not show the existence of certain utilities and features and the Work exposes or interacts with the utilities and features, these must be located and recorded by the Contractor.
- C. Services Alteration/ Abandonment / Demolition: Where existing infrastructure, building services and/or utilities are demolished or services realigned or abandoned this information must be reflected within the as-built site survey. A distinction must be made between services (or part services) which have been abandoned (but left in the ground) and those that have been physically removed.

### 1.11 SURVEY CHECK LIST

	Yes	No	N/A	Project Kickoff Phase
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor meet with DEN PM obtain the data standards and general requirements for data gathering?
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor meet with Airport Survey Office to obtain airport survey control points, projection parameters, and airport survey training materials?
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Survey Statement of Work to DEN PM?

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4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Geodetic Verification Survey to DEN PM?
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Survey Control Plan to DEN PM?
6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Imagery Plan to DEN PM? (Only required if collecting aerial imagery)?
7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the FAA accept survey plans?
	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>Construction Phase (As-Built)</b>
8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor perform field survey of project site to collect accurate as-built data?
9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the Contractor provide DEN PM with subsurface utility data?
10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Each week, did the Contractor provide DEN PM with Project Status Reports?
11	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the Contractor provide DEN PM with 25% as-built data in both CADD and GIS formats including all attribute information and metadata?
12a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did DEN PM report 25% QA findings via email to Contractor?
12b	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If required, did the Contractor provide DEN PM with 50% as-built data in both CADD and GIS formats including all attribute information and metadata?
12c	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If applicable, did DEN PM report 50% QA findings via email to Contractor?
12d	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If required, did the Contractor provide the DEN PM with 75% as-built data in both CADD and GIS formats including all attribute information and metadata?
12e	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If applicable, did DEN PM report 75% QA findings via email to Contractor?
13	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the Contractor provide DEN PM with 100% as-built data in both CADD and GIS formats including all attribute information and metadata?
14	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide DEN PM with a completed Final Survey Report?
15	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did DEN PM report QA findings via email to Contractor?

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.01 CONSTRUCTION LINES AND GRADES**

- A. The Contractor must make surveys and layouts as necessary to delineate the Work. The Contractor must make the surveys for the proper performance of the Work. As a part of such surveys, the Contractor must furnish, establish, and maintain in good order survey control points that may be required for the completion of the Work subject to the approval of the DEN Project Manager as to their location, sufficiency and adequacy. However, such approval by the DEN Project Manager must not relieve the Contractor of responsibility for the accuracy of the Contractor's survey work.
- B. The DEN Project Manager must have the right to check surveys and layouts made by the Contractor prior to approving any of the Work. The Contractor must give advance notice of not less than forty-eight (48) hours to the DEN Project Manager to enable such checking prior to placing any work. The Contractor must furnish assistance as may be required for

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checking purposes when so requested by the DEN Project Manager.

- C. The Contractor must furnish skilled labor, instrument platforms, ladders and such other temporary structures as may be necessary for making and maintaining points and lines in connection with the surveys required.
- D. The DEN Project Manager may draw the Contractor's attention to errors or omissions in lines or grades, but the failure to point out such errors or omissions must not give the Contractor any right or claim nor must in any way relieve the Contractor of obligations according to the terms of this Contract.
- E. The Contractor's instruments and other survey equipment must have current certification from manufacturer's representative Surveys must be performed under the direct supervision of a current Colorado Registered Licensed Land Contractor.
- F. Field Notes:
  - 1. The Contractor must record surveys in field notebooks or as electronic field notes, whichever is more appropriate to the type of survey work.
  - 2. If the DEN Project Manager finds errors in the field notes DEN must have the Contractor correct and resubmit the notes. This review does not relieve the Contractor from the responsibility of maintaining accurate survey data. Whichever method of note-taking the Contractor starts with, the Contractor must use the same method throughout the Contract duration.
- G. The DEN Project Manager may at any time use line and grade points and markers established by the Contractor. The Contractor's surveys are a part of the Work and may be checked by the DEN Project Manager or the DEN Project Manager's representatives at any time.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013223.11**

**SECTION 013223.15****SURVEY INFORMATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section covers Denver International Airport (DEN) procedures and accuracy requirements for survey control.
- B. Before commencing any field surveys on DEN property, the Contractor must coordinate a pre-survey preparation activities meeting. This meeting is to be arranged through the DEN Project Manager's Office with the attendance of the Contractor and the DEN Survey Section. The Contractor is responsible for obtaining DEN related survey guidance, Access to DEN survey network, Primary Control, projection parameters, and training materials from the DEN Survey at the pre-survey meeting and/or prior to beginning any survey work.
- C. Survey Project Checklist, provided after the end of this Section, will be reviewed at the pre-survey preparation activities meeting.

**1.03 REFERENCE DOCUMENTS:**

- A. Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples".
- B. Latest version of Federal Aviation Administration Advisory Circular 150/5300
- C. Latest Version of DEN BIM DSM (Design Standards Manual)
- D. Latest Version of Colorado Department of Transportation (CDOT) Survey Manual.
- E. Latest Version of Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Survey Statement of Work (SSOW):
  - 1. The Contractor must develop a complete SSOW in accordance with Specification Section 013223.11, "Construction Layout and As-Built Surveys".
- C. Survey and Quality Control Plan (SQCP):
  - 1. The Contractor must develop a complete SQCP in accordance with Specification Section 013223.11, "Construction Layout and As- Built Surveys".

**1.05 QUALITY REQUIREMENTS**

- A. Equipment Calibration:
1. Equipment must be regularly checked, and calibrated for accuracy at the beginning of any survey project to ensure that the equipment is operating appropriately. Errors due to poorly maintained or malfunctioning equipment will not be accepted. If any equipment errors are found to exist they must be reported to the DEN Survey prior to the start of any surveying. These errors must be verified and eliminated prior to performing any survey work. For projects lasting longer than six (6) months, the checking, and calibration of equipment must be repeated. Furthermore, documentation must verify such equipment has met acceptable tolerances.
  2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.
- B. See CDOT Survey Manual for acceptable procedures for calibrating equipment electronic survey instruments adjustments, calibration, or repairs:
1. All electronic survey instruments must be repaired, adjusted, or calibrated only by an authorized equipment vendor or manufacturers service department.
  2. A calibration check on all types of electronic survey instrumentation is essential to obtain and maintain the tolerances required for any DEN project. At the beginning of any DEN project, all survey equipment utilized to perform the survey must be calibrated by the surveyor in charge of the Project.
  3. See CDOT Survey Manual for acceptable procedures for calibrating equipment.
- C. Baseline Calibration Requirements:
1. See CDOT Survey Manual for the procedures to check the survey equipment and the method of reporting the findings to the DEN Project Manager and the DEN Survey Section.
  2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.

**1.06 SURVEY CONTROL**

- A. DEN utilizes its own local coordinate system that is tied to the National Spatial Reference System (NSRS). The DEN Survey Section will provide the data required to use this coordinate system during the mandatory pre-survey preparation activities meeting. The DEN Survey Section will also provide coordinates for all Primary Control Points based upon the location of the Project.
- B. The coordinates of the Primary Airport Control Station (PACS) and Secondary Airport Control Station (SACS) were correct at the time of installation (or subsequent date listed on the plan) but may be subject to the effects of subsequent subsidence and/ or disturbance. Marks with any noticeable signs of disturbance, damage, or location out of tolerance must be reported so that they can be repaired and/ or noted on the control plan. In addition, any marks that have been or will be destroyed either before or during Works must be noted and mentioned in the Survey Statement of Work and the Survey and Quality Control Plan. If removed or destroyed, the Contractor will create a plan and must replace the PACS or SACS.

- C. DEN is based on the North American Vertical Datum of 1988 (NAVD 1988). Vertical Control and Bench Marks must be tied into this datum. DEN has existing established National Geodetic Survey (NGS) vertical stations around its property and these points must be used in all DEN projects. Project control points must be established by performing measurements with a digital level from at least two NGS vertical stations that are given by the DEN Survey Section. The benchmarks used to establish ties to the datum must be shown in the Contractor's notes and on the CSP.
- D. The Contractor will be provided survey control from the DEN Survey Section. If the nearest NGS Vertical Station is a considerable distance from the site, the Contractor may establish a Temporary Survey Control Point (TSCP) near the site. Appropriate survey procedures must be used to establish any additional TSCP. A minimum of 3 TSM must be established for the project. Each must be visible and tied to at least 2 separate TSCP or PACS and/or SACS. It is the Contractor's responsibility to verify the stability of the mark over the life of the project. Where unacceptable discrepancies in control marks due to land settlement, disturbance or from other factors are apparent, the Contractor must refer the matter to DEN Project Manager for resolution prior to the continuation of Work.
- E. Horizontal Control is based on a local coordinate system. The Contractor must establish reliable horizontal control that will last the duration of the Project. Where unacceptable discrepancies in control marks due to land settlement, disturbance or from other factors are apparent, the Contractor must refer the matter to DEN Project Manager for resolution prior to the commencement of Work. The horizontal control establishing ties to the datum must be shown in the Contractor's notes and on the CSP.
- F. Geodetic Verification Survey Instructions and Procedures:
1. The geodetic verification survey is created to insure the stable position of the DEN Primary control points that are used to reference the TSCP to the NSRS. Acceptable monuments will be identified by the DEN Survey Section and will be limited to monuments of the NSRS with permanent identifiers (PIDS) and published positions and elevations. Temporary design/construction control points established for such project will be referenced by direct measurement to at least two (2) separate NGS control stations.
    - a. The Contractor must recover each identified monument and determine its condition, stability, and suitability for the intended use. A location sketch and visibility diagram will be prepared for each station. A minimum of three (3) digital photographs, one of each type described in AC 150/5300-18B, Section 1.5.2.1, will be captured, captioned, and properly named. A recovery note will be filed with NGS if no current recovery is shown in the NSRS database.
    - b. After recovering the identified NSRS NGS control stations that are located on DEN property, the procedure to verify the control points are as follows:
      - 1) DEN has created its own Virtual Reference System (VRS) Network that will be used on all survey projects. This network will be known as DENVRS.
        - a) This system is comprised of hardware and software designed to facilitate real-time GPS/GNSS positioning based on a set of reference stations.
        - b) DEN has created a control network that incorporates fifteen (15) Primary Control Points tied together with the reference stations for the DENVRS,
        - c) This network, in turn, is tied to the National Spatial Reference System (NSRS).
        - d) DEN will be monitoring the stations on an annual basis and the primary control points on an annual basis and the primary control points on a quarterly basis.
      - 2) The Consultant is required to validate the DENVRS by observing at least two (2) Primary control points using a Fast Static method

- a) Fast Static surveys allow for systematic errors to be resolved when high accuracy positions are required by collecting simultaneous data between stationary receivers for a shorter period of time than that of Static surveys. DEN will require an observation time of (15) minutes on all Primary control points. Each baseline between adjacent intervisible control points must be observed at least twice.
  - 3) The results must be reviewed and approved by the DEN Survey Office, allowing at least seventy-two (72) hours to review and either approve or reject the temporary control. All temporary control points **MUST BE** accepted before any design survey work can commence.
  - 4) Obtain elevation checks either from GPS observations or from digital levels. The distances must agree within, plus or minus, three ( $\pm 3$ ) cm; the difference in ellipsoidal height must agree within, plus or minus, four ( $\pm 4$ ) cm, and the difference in orthometric height must agree within, plus or minus, five ( $\pm 5$ ) cm. If the tolerances are not met the data must be recollected.
  - 5) Provide the results or the comparisons as part of the observational data in a report to the DEN Project Manager to be reviewed and approved by the DEN Survey Section prior to the start of construction and include this approved report in the final report.
  - 6) Submit a Recover Observe Report for the NGS horizontal control stations to the NGS. Refer to <https://www.ngs.noaa.gov/GPSONBM/Report.shtml> for the report format.
- G. Limitations and Additional Information for NGS Control Stations and NGS Benchmarks:
1. The use of control monuments and projection parameters for construction layout other than those shown on the Contract Drawings or furnished by or approved by the DEN Survey Section is **STRICTLY PROHIBITED**. Use of other monuments is solely at the risk of the Contractor.
  2. The DEN Survey Section will provide the Contractor with the projection parameters and any assistance in implementing the coordinate system. It is up to the Contractor to use the correct methodology in performing any survey task which must be submitted to the DEN Project Manager and reviewed during the pre-survey preparation activities meeting.
  3. The DEN Project Manager will need all pertinent data from the Contractor to check and verify that the Contractor implemented the coordinate system correctly.
- H. Modifications to AC 150/5300-18B, Section 2.6.10.1.1, Verification of Survey Marks:
1. DEN requires Contractor to verify the unmoved position and elevation of both the PACS and SACS for any airside projects and any two (2) DEN approved NGS control stations for any landside project.
  2. The Contractor must follow the same verification procedure as stated in Section G above.
- I. Reporting Damage or Errors of NGS Control Stations:
1. Report damaged or destroyed airport control points, bench marks, and section corner monuments promptly to the DEN Project Manager.
    - a. If section corner monuments are damaged or destroyed during construction activities, such points must be re-established pursuant to Laws of the State of Colorado Regulating the Practice of Land Surveying by a current Registered Professional Land Contractor in the State of Colorado.
    - b. If NGS control stations or NGS bench marks are damaged, moved, altered, or destroyed by the Contractor, DEN's cost of reestablishing such points must be

- borne by the Contractor.
- c. DEN will not be responsible for any increased costs or delays to the Contractor relating to reference points, airport control points, or bench marks which are damaged, moved, altered, or destroyed by the Contractor or its, suppliers, agents or employees or other Contractors working on the site.
2. Report alleged errors in NGS control stations or NGS bench marks promptly to the DEN Project Manager.
    - a. Discontinue use of NGS control stations or NGS bench marks alleged to be in error until the accuracy of points can be verified or as directed.
    - b. Claims for extra compensation for alteration or reconstruction allegedly due to errors in NGS control stations or NGS benchmarks will not be allowed unless original NGS control stations and NGS bench marks still exist or substantiating evidence proving error is furnished by the Contractor, and unless the Contractor has reported such errors to the DEN Project Manager as specified herein.

### **1.07 TEMPORARY SURVEY CONTROL**

- A. The Contractor **MUST** set a minimum of either 'chiseled X' in concrete; a drill hole with lead and tack in concrete; a PK nail with shiner in asphalt or concrete or a 5/8" rebar with plastic cap in natural ground. An 'Inked X' set as a control point is **UNACCEPTABLE**.
- B. When a Contractor establishes TSCP for DEN survey work the Contractor **MUST** follow FAA guidelines. All TSCP must be referenced to the National Spatial Reference System (NSRS) using the NGS control stations provided by the DEN Survey Section. Temporary control may be necessary based on project site location. Below are the acceptable means to establish temporary geodetic control for DEN design or construction projects:
  1. Temporary control must be established under close cooperation with the DEN Survey Section following the procedures outlined in AC150/5300-16 "General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to National Geodetic Survey" only in the following cases:
    - a. Large airport construction projects that significantly changes the airport geometry and would trigger the need to acquire new Digital Stereo Imagery following AC 150/5300-17 "General Guidance and Specification for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey". Examples include a new runway and taxiway complex, significant modification of existing runway or taxiway system, development of new outboard deice pad complex or establishment of new mid airfield concourse and terminal complex. The size and complexity of the Project will dictate the need to acquire new digital stereo imagery for significant construction.
    - b. Construction that establishes a new ILS CAT II/III Operations.
    - c. New Instrument Development Procedure.
    - d. New Airport Layout Plan Survey Update.
    - e. New Airport Obstruction Chart Update.
    - f. New Airport Mapping Database.
  2. On DEN projects, the Contractor, may use TSCPs on their project site. These TSCP must be referenced to the nearest two (2) DEN primary control points and **MUST BE** referenced vertically to two (2) different NGS benchmarks. Also, all Contractors **MUST** obtain permission to establish TSCPs on DEN property by means of communicating with the DEN Survey Section.
  3. In addition, all vertical control **MUST BE** established only using a digital level unless otherwise authorized by the DEN Survey Section.
  4. Minimum Construction Horizontal and Vertical Accuracy Tolerance:

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- a. Adjustments:
    - 1) No adjustment of the survey field data will be permitted without the written consent of the DEN Project Manager. If it is determined that an adjustment is necessary, a weighted least squares adjustment method is recommended.
  - b. Primary NGS vertical stations values must be held unless the Contractor has determined that there is an issue with one of the values. If this is the case, the Contractor must notify the DEN Project Manager to determine which other Primary stations can be used.
  - c. Secondary Control Project Benchmark Minimum Vertical Accuracy Tolerance:
    - 1) Setting of secondary control benchmarks must meet the Minimum Vertical Accuracy Tolerance of the square root of the total horizontal distance of the level loop in miles multiplied by 0.035 feet.
    - 2) The results of this evaluation must be recorded in the field book for each differential level loop. At least two (2) established NGS benchmarks on the same datum must be used to verify that the starting mark has not been disturbed.
5. Whether establishing TSCPs or not, the Contractor must set up a Pre-Survey Preparation Activity meeting with the DEN Project Manager to discuss Geodetic Control Verification, obtain pertinent survey data, and projection parameters before the commencement of any survey work.
  6. If TSCPs are needed, the Contractor can set and collect temporary control while performing as outlined in Part 1 of this Section. Once the data is collected the Contractor is required to submit all pertinent data to the DEN Project Manager. This data must include all GPS raw data in a Trimble format with an Excel spreadsheet that displays the comparison from each observation of the NGS control stations. The comparison must include showing the delta northings, delta eastings, and delta elevations for each redundant pair of control points Contractor Only the redundant values of the TSCPs should be averaged. The results must be reviewed and accepted by the DEN Project Manager, allowing at least seventy-two (72) hours to review and either approve or reject the temporary control. All TSCPs MUST BE approved before any survey work can commence.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013223.15**

**SECTION 013223.19****QUANTITY SURVEYS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section covers Denver International Airport DEN procedures and accuracy requirements for survey services for construction layout, as-built and quantity surveys.
- B. Before commencing any field surveys on DEN property, the Contractor must coordinate a pre-survey preparation activities meeting. This meeting is to be arranged through the DEN Project Manager's Office with the attendance of the Contractor, the Contractor's surveyor, and the DEN Survey Section. The Contractor is responsible for obtaining DEN related survey guidance, primary control stations, projection parameters and training materials from the DEN Survey Section prior to beginning any survey work.
- C. Reference Contract General Conditions.

**1.03 REFERENCE DOCUMENTS:**

- A. ~~Section 013326 "Survey Control"~~.
- B. Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples".
- C. Latest version of Federal Aviation Administration Advisory Circular 150/5300
- D. Latest Version of DEN BIM DSM (Design Standards Manual)
- E. Latest Version of Colorado Department of Transportation (CDOT) Survey Manual.
- F. Latest Version of Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Weekly Project Status Report:
  - 1. Contractor must submit a project status report in compliance with FAA AC 150/5300-18B to the DEN Project Manager every Monday by 2:00 P.M. Mountain Time, from the date of the task order until the date of Substantial Completion
  - 2. The Weekly Project Status Report must use format from AC 150/5300-18B
- C. Final Project Survey Report:

1. The Final Project Survey Report, must use format from AC 150/5300-18B
2. Final Project Survey Report must be stamped and wet signed by a current Colorado Registered Professional Land Surveyor.

### **1.05 QUALITY REQUIREMENTS**

#### **A. Equipment Calibration:**

1. Equipment must be regularly checked, and calibrated for accuracy at the beginning of any survey project to ensure that the equipment is operating appropriately. Errors due to poorly maintained or malfunctioning equipment will not be accepted. If any equipment errors are found to exist they must be reported to the DEN Survey prior to the start of any surveying. These errors must be verified and eliminated prior to performing any survey work. For projects lasting longer than six (6) months, the checking, and calibration of equipment must be repeated. Furthermore, documentation must verify such equipment has met acceptable tolerances.
2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.

#### **B. See CDOT Survey Manual for acceptable procedures for calibrating equipment electronic survey instruments adjustments, calibration, or repairs:**

1. All electronic survey instruments must be repaired, adjusted, or calibrated only by an authorized equipment vendor or manufacturers service department.
2. A calibration check on all types of electronic survey instrumentation is essential to obtain and maintain the tolerances required for any DEN project. At the beginning of any DEN project, all survey equipment utilized to perform the survey must be calibrated by the surveyor in charge of the Project.
3. See CDOT Survey Manual for acceptable procedures for calibrating equipment.

#### **C. Baseline Calibration Requirements:**

1. See CDOT Survey Manual for the procedures to check the survey equipment and the method of reporting the findings to the DEN Project Manager and the DEN Survey Section.
2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 QUANTITY SURVEYS FOR PAYMENT**

- A. When the specifications or the DEN Project Manager require items in the Schedule of Prices and Quantities to be measured by surveying methods, the Contractor must perform the surveys.
- B. All such surveys, including control surveys run for establishing the measurement reference lines, must be performed in the presence of the DEN Project Manager or the DEN Project

Manager's representative who will witness the surveying operation and who will acknowledge receipt of the field notes or keep duplicate field notes, at the DEN Project Manager's option.

- C. The Contractor must reduce the field notes and calculate final quantities for payment purposes. The note reductions and calculations must be given to the DEN Project Manager.

#### **PART 4 - MEASUREMENT**

##### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013223.19**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 013223.19 – QUALITY SURVEYS**

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**SECTION 013233****PHOTOGRAPHIC DOCUMENTATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for the following:
  - 1. Preconstruction photographs.
  - 2. Periodic construction photographs.
  - 3. Final Completion construction photographs.
  - 4. Preconstruction video recordings.
  - 5. Periodic construction video recordings.
  - 6. Web-based construction photographic documentation.

**1.03 REFERENCE DOCUMENTS:**

- A. Section 013300 "Submittal Procedures"
- B. Section 017720 "Contract Closeout"
- C. Section 017900 "Demonstration and Training"

**1.04 ALTERNATES**

- A. Refer to Section 012300 "Alternates"

**1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For photographer.
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- C. Digital Photographs: Submit image files within three (3) days of taking photographs.
  - 1. Digital Camera: Minimum sensor resolution of 10 megapixels.
  - 2. File Format: Minimum 3200 by 2400 pixels, in unaltered .RAW original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
  - 3. Identification: Provide the following information with each image description in file metadata tag:
    - a. Project title and Project number.
    - b. Name and contact information for photographer.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 013233 – PHOTOGRAPHIC DOCUMENTATION**

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- c. Name of DEN Project Manager.
  - d. Name of Contractor.
  - e. Date photograph was taken.
  - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    - 1) Include work order number or change order number if applicable.
  - g. Unique sequential identifier keyed to accompanying key plan.
  - h. Photograph number.
- D. Video Recordings: Submit video recordings within seven (7) days of recording.
1. Submit video recordings in an electronic format acceptable to DEN Project Manager by posting to Project Web site. Recordings shall be high-resolution 1080p with a minimum framerate of 60Hz.
  2. Identification: With each submittal, provide the following information:
  3. Name of Project.
  4. Name and address of photographer.
  5. Name of DEN Project Manager.
  6. Name of Contractor.
  7. Date video recording was recorded.
  8. Description and key plan of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
  9. Weather conditions at time of recording.
- E. Web-Based Photographic Documentation: Submit time-lapse sequence video recordings simultaneously with recording.
1. Submit time-lapse sequence video recordings by posting to Project Web site.
  2. Identification: For each recording, provide the following information:
    - a. Name of Project.
    - b. Name and contact information for photographer.
    - c. Name of DEN Project Manager.
    - d. Name of Contractor.
    - e. Date(s) and time(s) video recording was recorded.
    - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    - g. Weather conditions at time of recording.

**1.06 QUALITY ASSURANCE**

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.
- B. Web-Based Photographic Documentation Service Provider: A firm specializing in providing photographic equipment, Web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project for not less than three years.

**1.07 USAGE RIGHTS**

- A. Obtain and transfer copyright usage rights from photographer to City and County of Denver for unlimited reproduction of photographic documentation.

## **PART 2 - PRODUCTS**

### **2.01 PHOTOGRAPHIC MEDIA**

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 10 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.
- B. Digital Video Recordings: Provide high-resolution 1080p with a minimum framerate of 60Hz in electronic format acceptable to DEN Project Manager.

### **2.02 WEB-BASED PHOTOGRAPHIC DOCUMENTATION**

- A. Project Camera: Provide fixed exterior camera installation, mounted to provide unobstructed view of construction site from location approved by DEN Project Manager.
  - 1. Provide one fixed-location camera(s), with the following characteristics:
    - a. Static view or remotely controllable view with mouse-click user navigation for horizontal pan, vertical tile, and optical zoom of 500 percent minimum.
    - b. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.
- B. Wireless Hand-Held Camera: Provide portable camera system capable of producing images complying with requirements in this Section, with wireless transmission to service provider's network enabling a live image stream viewable by multiple parties.
  - 1. Provide battery charger, spare battery pack, base station hub, and base station connections in a number and distribution adequate to enable wireless camera operation throughout Project site. Contractor responsible for ensuring camera stays in operation.
  - 2. Provide power supply, active high-speed data connection to service provider's network, and static public IP address at base station hub. Provide power supply, conduit, and data wiring between base station hub and base station connections.
- C. Web-Based Image Access: Password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
  - 1. Provide public viewer open access to most recent project camera image.

## **PART 3 - EXECUTION**

### **3.01 CONSTRUCTION PHOTOGRAPHS**

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to show clearly the Work. Photographs with blurry or out-of-focus areas will not be accepted.
  - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.

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**TECHNICAL SPECIFICATIONS**  
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- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software. Provide commercial quality, digital color photographs in PDF format. PDF file shall be security-free, bookmarked by date with all photos rotated to the correct orientation. Identify the following information on each photograph on the lower right corner.
1. Subject description (include work order number or change order number if applicable)
  2. Station point of camera and direction of view. Include letter size diagram of project indicating Station point
  3. Date and time each photo was taken
  4. Name of Contractor.
  5. Photograph number
  6. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to DEN Project Manager.
- D. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by DEN Project Manager.
1. Flag construction limits before taking construction photographs.
  2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
  3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
  4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
  5. Haul route, laydown yard, and other locations as directed by DEN Project Manager.
- E. Periodic Construction Photographs: 20 photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- F. DEN Project Manager-Directed Construction Photographs: From time to time, DEN Project Manager will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.
- G. Time-Lapse Sequence Construction Photographs: Take 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
1. Frequency: Take photographs monthly, coinciding with the cutoff date associated with each Application for Payment.
  2. Vantage Points: Following suggestions by DEN Project Manager and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
    - a. Commencement of the Work, through completion of subgrade construction.
    - b. Above-grade structural framing.
    - c. Exterior building enclosure.
    - d. Interior Work, through date of Substantial Completion.

- H. Final Completion Construction Photographs: Take 20 color photographs after date of Substantial Completion for submission as project record documents. DEN Project Manager will inform photographer of desired vantage points.
1. Include date stamp.
- I. Additional Photographs: DEN Project Manager may request photographs in addition to periodic photographs specified. Additional photographs shall be paid for by Change Order and are not included in the Contract Sum.
1. Three days' notice shall be given, where feasible.
  2. In emergency situations, take additional photographs within 24 hours of request.
  3. Circumstances that could require additional photographs include, but are not limited to, the following:
    - a. Special events planned at Project site.
    - b. Immediate follow-up when on-site events result in construction damage or losses.
    - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    - d. Substantial Completion of a major phase or component of the Work.
    - e. Extra record photographs at time of final acceptance.
    - f. DEN's request for special publicity photographs.

### **3.02 CONSTRUCTION VIDEO RECORDINGS**

- A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.
- B. Recording: Mount camera on tripod before starting recording unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.
- C. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
1. Confirm date and time at beginning and end of recording.
  2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.
- D. Preconstruction Video Recording: Before starting construction, record video recording of Project site and surrounding properties from different vantage points, as directed by DEN Project Manager.
1. Flag construction limits before recording construction video recordings.
  2. Show existing conditions adjacent to Project site before starting the Work.
  3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of construction.
  4. Show protection efforts by Contractor.
- E. Periodic Construction Video Recordings: Record video recording monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show

status of construction and progress since last video recordings were recorded. Minimum recording time shall be 30 minutes(s).

- F. Time-Lapse Sequence Construction Video Recordings: Record video recording to show status of construction and progress.
1. Frequency: During each of the following construction phases, set up video recorder to automatically record one frame of video recording every five (5) minutes, from same vantage point each time, to create a time-lapse sequence of 30 minutes in length as follows:
    - a. Commencement of the Work, through completion of subgrade construction.
    - b. Above-grade structural framing.
    - c. Exterior building enclosure.
  2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.
  3. Vantage Points: Following suggestions by DEN Project Manager and Contractor, photographer shall select vantage points.

### **3.03 WEB-BASED CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION**

- A. Live Streaming Construction Site Images: Provide Web-accessible image of current site image from fixed or viewer-controlled location camera(s), updated at 15 minute intervals during daytime operation.
- B. Time-Lapse Sequence Construction Site Recordings: Provide video recording from a fixed-location camera to show status of construction and progress.
1. Frequency: Record one frame of video recording every 15 minutes, from same vantage point each time, to create a time-lapse sequence of construction activities.
  2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.
- C. Maintain cameras and Web-based access in good working order according to Web-based construction photographic documentation service provider's written instructions until Final Completion. Provide for service of cameras and related networking devices and software.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013233**

**SECTION 013300**  
**SUBMITTAL PROCEDURES**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section summarizes the requirements for the submittal of documents to the DEN Project Manager that are defined in these Specifications. It also describes the procedures for "supplemental" submittals.
- B. The Contractor must follow all the requirements of the procedures and the product details and keep all the submittals current and approved prior to any placement of work.

**1.03 SUBMITTAL SCHEDULE**

- A. The Contractor shall provide a submittal schedule within 14 days after Notice to Proceed. The Submittal Schedule shall be directly related to the CPM schedule, shall identify all the submittals, and shall include the following information for each submittal item
1. Specification section, Contract article, or special condition.
  2. Specification Subparagraph.
  3. Item description.
  4. Date the submittal shall be submitted.
  5. Name of subcontractor or supplier.
- B. The submittal schedule shall be kept current by the Contractor and submitted with the progress payment requests.
- C. For large files that cannot be loaded or e-mailed through the electronic Project Manager application (Unifier), submit the files on a CD, DVD, or USB flash drive media.

**1.04 ELECTRONIC SUBMITTALS**

- A. Before the initiation of the submittal process, coordinate and ensure that all submittals comply and follow the requirements of the DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and the DEN BIM PXP.
- B. Submit request for progress payment applications utilizing TEXTURA software as instructed by DEN Project Manager.
- C. Submit Subcontractor's Contract information required by the City and County of Denver Small Business Office as instructed by DEN Project Manager.
- D. Submit original electronic copies of all City and County of Denver Development Department/ Building Inspection Department Approved drawings including all approvals of Deferred Submittals; including but not limited to shoring plans, Fire Protection distribution

plans, and structural shop drawings to DEN Project Manager as Informational Submittals. The lack of approval of the Denver Development Services on any document shall be basis for rejection of Work and non-compliance.

1. NOTE: Only original copies shall be accepted. Scans will not be accepted.
- E. Submit electronically scanned copies of all documents required by Chapter 17 “Special Inspection and Testing” of the International Building Code 2009 as amended by City and County of Denver 2011. Keep scale and clarify dimension where electronic copies are not as originally scaled and dimensioned.
- F. All submittals shall be delivered to the DEN Project Manager utilizing the Primavera Construction Manager program (PCM) as attachments and as separate file when files are too large to attach or of an electronic media that is not supported by PCM or Utilizing the EPPM Unifier software uploaded to the share drive Unifier’s project site when directed by DEN Project Manager.
  1. Acceptable electronic formats
    - a. Print document format (pdf) shall have no security and bookmark every applicable submittal. All pages shall be completely legible and oriented to correct reading view.
    2. Formats are acceptable only with written permission of the DEN Project Manager or required by the BIM PXP. For files in any of the following formats, the corresponding stringency will apply:
      - a. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.
        - 1) AutoCAD files shall be self-contained with no external x-references.
      - b. BIM files shall conform to the standards and formats outlined in the BIM PXP and DEN BIM DSM.
      - c. Portable Document Format (PDF) files shall be compatible with Adobe Acrobat 10.0, non-password-protected, and security-free.
      - d. Other files pre-approved by the DEN Project Manager.

### **1.05 INITIAL SUBMITTAL**

- A. Each submittal document shall include a title block showing the following information:
  1. Date of submittal and revision dates.
  2. Contract title and number.
  3. The names of Contractor, subcontractor, supplier, manufacturer and when applicable, the seal and signature of an Engineer registered in the State of Colorado, for the involved discipline.
  4. Identification of product by either description, model number, style number or lot number.
  5. Subject identification by Contract Drawing or specification reference.
- B. On each submitted drawing, include a blank space on each sheet, three inches by four inches, in the lower right corner, just above the title block, in which the DEN Project Manager or the Designer of Record may indicate the action taken.
- C. Make submissions sufficiently in advance so that the DEN Project Manager Review may be completed not less than 30 days before Work represented by those submittals is scheduled to be performed.

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- D. Allow a minimum cycle of 30 days for review of each submittal by the DEN Project Manager.
- E. Accompany submittal documents with DEN transmittal form CM-30, Submittal, which shall contain the following information:
1. Contractor's name, address and telephone number.
  2. Submittal number and date.
  3. Contract title and number.
  4. Supplier's, manufacturer's, or subcontractor's name, address and telephone number.
  5. Identification of variations from Contract Documents.
  6. Contractor's stamp and signature certifying the Contractor's review.
  7. Identification of submittal:
    - a. If the submittal is being made on a General Condition or Special Condition, reference the General or Special Condition number the first two digits of the specification section shall be 00XXXX.
    - b. If the submittal is being made under a specification section, reference the specification number, paragraph number, and subparagraph number.
    - c. If the submittal is being made under a drawing, reference the drawing(s) number and sub-number.
- F. The Contractor shall describe, at the time of submission, variations from the Contract documents in writing, separate from the submittal document. If the DEN Project Manager approves any such variations, an appropriate Contract change order shall be issued, except that if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued. If a submission contains variations and the variation column is not marked on the transmittal form, it will not be considered for review and acceptance. Along with marking the transmittal as a variation, a description must be included which outlines all the differences including maintenance and utility services along with any cost savings from an item not containing the variation.
- G. Changes in accepted submittal documents will not be permitted unless those changes have been accepted, in writing, by the DEN Project Manager.
- H. The form and quality of submittal documents shall comply with Section 013325 "Shop and Working Drawings, Product Data, and Samples."

**1.06 SUPPLEMENTAL SUBMITTALS**

- A. Supplemental submittal documents initiated by the Contractor for consideration of corrective procedures shall contain sufficient data for review. Make supplemental submittals in the same manner as initial submittals with the appropriate primary transmittal referenced.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 CONTRACTOR'S REVIEW**

- A. The Contractor shall review all submittal documents, stamp, and sign as reviewed and approved as complying with Contract Documents prior to submission to the DEN Project Manager. Submittal documents that are submitted to the DEN Project Manager THAT

HAVE NOT BEEN REVIEWED BY THE CONTRACTOR will not be reviewed and will be returned to the Contractor. Contractor is responsible for any delays in the Project due to improperly reviewed, stamped, and signed submittals.

- B. The Owner review period will be limited to ten (10) business days from the time complete submittal documents have been submitted.
- C. The Contractor is responsible to obtain all approvals for all deferred submittals, shop drawings, and significant changes from the CCD Development Service Department.
- D. All submittals must delineate any deviation from the intended design and must submit request for substitution to address any significant variation. Refer to Title 4, Article 405 – Shop Drawings, Product Data, and Samples, and Article 406 – Substitution of Materials and Equipment of the General Contract Conditions, 2011 Edition.

### **3.02 REVIEW BY DEN PROJECT MANAGER**

- A. Submittal documents will be reviewed by the DEN Project Manager, the DEN Project Manager Team, and/or the DOR for conformance to requirements of the Contract Documents. Review of a separate item will not constitute review of an assembly in which the item functions. The DEN Project Manager will withhold approval of submittals that depend on other submittals not yet submitted. Review and acceptance will not relieve the Contractor from the Contractor's responsibility for accuracy of submittals, for compliance with all applicable regulations, for compliance with all codes and specifications, for conformity of submittal document to requirements of Contract Drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection and completion of the Contract in accordance with the Contract Drawings and specifications. Acceptance is not verification or certification that the submittals comply with all requirements nor does it guarantee approval by the Denver Building Department or Denver Fire Department.
- B. The City, the DOR, and/or the DEN Project Manager will review the submittal documents for general conformance with the Contract Documents and mark the Action Code, sign, and date the transmittal.
- C. The Action Codes have the following meanings:
  - 1. Accepted (ACC)
    - a. The submittal conforms to the respective requirements of the contract documents.
  - 2. Accepted as Noted (AAN)
    - a. The submittal conforms to the respective requirements of the Contract Documents after changes are made in accordance with reviewer's comments. AAN submittals do not need to be resubmitted.
  - 3. Revise and Resubmit (R&R)
    - a. The submittal is unacceptable and must be revised and resubmitted.
  - 4. Rejected (REJ)
    - a. The submittal is not approved and a new submittal in accordance with the Contract Documents must be prepared and submitted.
  - 5. For Information Only (FIO)
    - a. An item is received by the DEN Project Manager but is not reviewed.

### **3.03 CONTRACTOR'S RESPONSIBILITIES**

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- A. Coordinate each submittal document with the requirements of the Work. Place particular emphasis upon ensuring that each submittal of one trade is compatible with other submittals of that trade and submittals of other trades including producing as needed drawings showing the relationship of the Work of different trades.
- B. Contractor's responsibility for errors and omissions in submittal documents and associated calculations is not relieved by the DEN Project Manager's review, correction, and acceptance of submittals.
- C. Contractor's liability to the City, in case of variations in the submittal document from the requirements of the Contract Documents, is not relieved by the DEN Project Manager's review and acceptance of submittals containing variations unless the DEN Project Manager expressly approves the deviation in writing, in which the DEN Project Manager describes the variation.
- D. The Contractor shall maintain a file of all approved submittal documents at the work site. The complete file of approved submittal documents shall be turned over to the DEN Project Manager with the as-built documents at the end of the job.
- E. Schedule impact due to resubmittal requirements is the responsibility of the Contractor.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013300**

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**SECTION 013325****SHOP AND WORKING DRAWINGS, PRODUCT DATA, AND SAMPLES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparing and submitting shop and working drawings, product data, samples, and record documents required by other specifications Sections.
1. The Contractor shall submit all shop drawings, working drawings, product data, and samples, as defined in the General Conditions, to the DEN Project Manager in accordance with the requirements in the technical specifications. The DEN Project Manager will return one (1) copy of the shop drawings, working drawings and product data to the Contractor with a written transmittal.
- B. The Contractor shall not submit as shop drawings, copies or reproductions of drawings issued to the Contractor by DEN.
- C. Related Requirements
1. Section 013300 "Submittal Procedures
  2. Section 012510 "Substitutions"
  3. Section 017720 "Contract Closeout"

**1.03 SUBMITTALS**

- A. All submittals shall be delivered to the DEN Project Manager in electronic format. All submittals must be of a consistent format (all PDF). No combination of electronic file types will be allowed unless required by a specific specification section.
1. Acceptable electronic formats: Comply with the electronic file formats approved by DEN Building Information Modeling (BIM) Design Standards Manual If any of the files are in any of the formats listed below then the version of the software shall be no less than identified below:
    - a. Adobe Acrobat 8.0 or newer. All files shall be fully compatible with Adobe Acrobat 8.0.
    - b. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.
    - c. AutoDesk AutoCAD 2007 or newer. All files shall be fully compatible with AutoDesk AutoCAD 2007.
      - 1) AutoCAD files shall be self-contained with no external x-references.
    - d. BIM format outlined in the BIM Project Execution Plan (PXP)
    - e. Other files pre-approved by the DEN Project Manager.
  2. Adobe Acrobat Requirements:
    - a. Drawings shall have security set to "No Security." Commenting, printing, adding

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- photos, form fields and document signing must be allowed.
- b. PDF submittals shall be one continuous file or Portfolio. No external links are allowed.
  - c. All individual components of submittals shall be bookmarked inside the PDF file.
  - d. All original documents shall be directly converted from the original electronic format to PDF. Scanning of files shall only be allowed by the DEN Project Manager when the original electronic information is not obtainable.
  - e. Failure to comply with these requirements will result in a return of file to the Contractor for immediate revision.
3. Electronic files submitted shall correspond with DEN File Control Numbering System available from the DEN Project Manager.
- B. Quantities**
1. One (1) electronic submittal in Unifier containing electronic files of each shop or working drawing.
  2. One (1) electronic submittal in Unifier containing electronic files of manufacturer's standard schematic drawings.
  3. One (1) electronic submittal in Unifier containing electronic files of manufacturer's calculations and manufacturer's standard data.
  4. One (1) electronic submittal in Unifier containing electronic files of manufacturer's printed installation, erection, application, and placing instructions.
  5. Nine (9) samples of each item specified in the various specification sections, unless otherwise specified.
  6. One electronic submittal in Unifier containing electronic files of inspection, test reports, and certificates of compliance.
  7. Note: If manufacturer's printed information is in color, all copies of submittals must be in color.
- C. Review:**
1. Submittal review comments by the DEN Project Manager will be in electronic form and incorporated into the electronic submittal file.
  2. Resubmittals of electronic documents shall modify the original electronic file with new information and include the DEN Project Manager's comments with appropriate responses and additional information.

**1.04 CHANGES**

- A. Changes in products for which shop or working drawings, product data or samples have been submitted will not be permitted unless those changes have been accepted and approved in writing by the Deputy Manager of Aviation as provided in Section 012510 "Substitutions."

**1.05 QUALITY CONTROL**

- A. Shop drawings and record documents shall be prepared to the standards of quality outlined in the specifications, DSM and BIM PXP, prepared and printed from Revit and checked in the spatial coordination format specified in the BIM PXP.
- B. Refer to DEN DFI DSM for other requirements that may be applicable to this Article.

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**PART 2 - PRODUCTS**

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**2.01 SHOP AND WORKING DRAWINGS**

- A. Prepare shop and working drawings in an electronic format that is current and approved by DEN to a scale large enough to easily depict and annotate each of the various items.
- B. Comply per other BIM requirements for Shop and Working Drawings as established in the DEN BIM DSM.
- C. Include the following as they apply to the subject:
  - 1. Contract title, work order, and number.
  - 2. Respective Contract drawing numbers.
  - 3. Applicable specification section numbers.
  - 4. Relation to adjacent structure or materials.
  - 5. Field dimensions clearly identified as such.
  - 6. Applicable standards such as ASTM or Federal Specification number, FAA, AASHTO, and pertinent authority specifications or standards.
  - 7. Identification of deviations from the Contract Drawings and specifications.
  - 8. Drawing name, number, and revision.
  - 9. Contractor's stamp, initialed or signed, certifying:
    - a. Verification of field measurements.
    - b. Review of submittals for compliance with Contract requirements.
    - c. Compatibility of the Work shown thereon with that of affected trades.
  - 10. Blank space on each sheet per Technical Specifications Section 013300 "Submittal Procedures."
- D. Drawings of equipment and other items that contain multiple parts shall include exploded views showing the relationship of parts and the description of the parts into the smallest units that may be purchased or serviced.
- E. Comply with all submittal requirements of Section 013300 "Submittal Procedures."

**2.02 PRODUCT DATA**

- A. Modify manufacturer's standard and/or schematic drawings to delete information that is not applicable to the Contract. Supplement standard information with additional information applicable to this Contract.
- B. Modify manufacturer's standard(s), diagrams, schedules, performance charts, illustrations, calculations, and other descriptive data to delete information that is not applicable to the Contract. Indicate dimensions, clearances, performance characteristics, and capacities. Include with the submittal electrical, plumbing, HVAC, and any other diagrams, as applicable.
- C. Modify erection, application, and placing instructions to delete information that is not applicable to the Contract or work order.
- D. Include the following:
  - 1. Contract title, work order, and number.

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2. Respective Contract drawing numbers.
  3. Applicable Contract technical specification section numbers.
  4. Applicable standards such as ASTM or Federal Specification number, FAA, AASHTO and pertinent authority specifications or standards.
  5. Identification of deviations from the Contract Drawings and specifications.
  6. Contractor's stamp, initialed or signed, certifying:
    - a. Dimensional compatibility of the product with the space in which it is intended to be used.
    - b. Review of submittals for compliance with Contract requirements.
    - c. Compatibility of the product with other products with which it is to perform or which will be next to it.
    - d. The products electrical, plumbing, control and HVAC requirements conform to Contract Documents and the necessary utilities are provided for in the Contract Documents.
- E. Comply with all submittal requirements of Section 013300 "Submittal Procedures."

**2.03 SAMPLES**

- A. Submit samples of sizes and quantities to clearly illustrate full color range and functional characteristics of products and materials including attachment devices.
- B. Erect field samples and mockups at the work site as specified in specification Sections and at locations acceptable to the DEN Project Manager. All field samples shall be erected in a location that will be readily visible throughout the life of the Contract to allow comparison of the Work as it progresses to the field sample. Field samples and mockups may be incorporated into the Work at Contractor's risk if approved by DEN Project Manager.
- C. The Contractor shall verify, through appropriate inspections and tests, that the samples submitted meet the specifications and shall provide inspection and test data with the samples. The review and comments on the sample shall not relieve the Contractor of the Contractor's responsibility for completion of the Contract.
- D. Show the following information:
  1. Contract title and number.
  2. Respective Contract drawing numbers.
  3. Applicable technical specification section numbers.
  4. Applicable standards such as ASTM or Federal Specification number.
  5. Identification of deviations from the Contract Drawings and specifications
  6. Contractor's stamp, initialed or signed, certifying:
    - a. Dimensional compatibility of the product with the space in which it is intended to be used
    - b. Review of submittals for compliance with Contract requirements
    - c. Compatibility of the product with other products with which it is to perform or which will be next to it
  7. If multiple samples are submitted and the DEN Project Manager is requested to make a choice, each sample shall have a unique identification number attached to it so the returned transmittal can state the identification number of the accepted sample and the Contractor will know which one it is.

- E. Comply with all submittal requirements of Section 013300 "Submittal Procedures."

## **PART 3 - EXECUTION**

### **3.01 CONTRACTOR RESPONSIBILITIES**

- A. Verify field measurements, catalog numbers, and similar data.
- B. The Contractor shall not start work for which submittals are required until a transmittal has been received by the Contractor marked with the Action Code ACCEPTED or ACCEPTED AS NOTED by the DEN Project Manager.
- C. Before making submittals, ensure that the products will be available in the quantities and at the times required by the Contract.
- D. Submit final, corrected, electronic copies of Contract and shop and working drawings showing the Work as actually installed, placed, erected, and applied. Refer to Section 017720 "Contract Closeout."

### **3.02 REVIEW BY THE DEN PROJECT MANAGER**

- A. One (1) electronic copy of the marked-up shop and working drawing and one (1) electronic copy of the product data will be returned to the Contractor by the DEN Project Manager. Only the transmittal form appropriately marked with the Action Code and comments, if any, will be returned on sample submittals.
- B. Contractor's responsibility for errors and omissions in submittals for compatibility will not be reduced, waived or otherwise limited by the review and acceptance of submittals by the DEN Project Manager. Review and acceptance will not relieve the Contractor from the Contractor's responsibility for accuracy of shop drawings, for compliance with all codes and specifications, for conformity to requirements of Contract Drawings and specifications, for compatibility of products with contiguous products and the rest of the system, or for protection and completion of the Contract in accordance with the Contract Drawings and specifications. Approval is not verification or certification that the shop drawings comply with all requirements nor does it guarantee approval by the Denver Building Department or Denver Fire Department.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013325**

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**SECTION 013510**  
**CONSTRUCTION SAFETY**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. For Airside Construction Projects Related Specification Sections include:
  - 1. Section 011430 "Vehicle and Equipment Permitting".
  - 2. Section 011810 "Utilities Interface".

**1.02 SUMMARY**

- A. Work specified in this Section includes construction safety precautions and programs by the Contractor and the basis for reviews by the DEN Project Manager.
- B. For projects enrolled under a DEN Owner Controlled Insurance Program (OCIP) or Rolling Owner Controlled Insurance Program (ROCIP) reference the Contract Special Conditions and applicable DEN OCIP or ROCIP Safety Manual, included as Contract Documents, for additional safety requirements.
- C. For projects not enrolled under a DEN Owner Controlled Insurance Program (OCIP) or DEN Rolling Owner Controlled Insurance Program (ROCIP) reference the Contract Special Conditions for all safety requirements.

**1.03 RESPONSIBILITY**

- A. The Contractor is responsible for the health and safety of the Contractor's personnel, agents, subcontractors and their personnel, and other persons on the worksite, for the protection and preservation of the Work and all materials and equipment to be incorporated therein, and for the worksite and the area surrounding the worksite. The Contractor shall take all necessary and reasonable precautions and actions to protect all such persons and property.
- B. This Section shall be interpreted in its broadest sense for the protection of persons and property by the Contractor and no action or omission by the DEN Project Manager or the DEN Project Manager's authorized representatives shall relieve the Contractor of any of its obligations and duties hereunder.

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Contractor's Site Specific Safety Plan:
  - 1. The Contractor's Site Specific Safety Plan shall be submitted and accepted as provided in the Contract prior to commencing any Work. If a Task Order or Change Order is issued where the Work is not covered by the Contractor's Site Specific Safety Plan, then a revision to the Safety Plan specific for the Work in the Task Order shall be resubmitted for approval. The Contractor's Safety Plan must meet requirements as

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outlined in the Contract. The Contractor should reference the applicable insurance requirements, including any Safety Manual and updates, and all applicable federal, state, and local laws and regulations. Additionally, for Airside Projects, the Contractor's Site Specific Safety Plan shall be developed according to the guidelines and requirements provided in the most current version of FAA Advisory (AC) 150/5370 "Operational Safety on Airports During Construction" and will describe how the Contractor will comply with the requirements of the Construction Safety and Phasing Plan (CSPP). The Site Specific Safety Plan shall cover the actions of not only the construction personnel and equipment, but the actions of inspection personnel and airport staff for the duration of construction activities.

2. No progress payment shall be approved until the Contractor's Site Specific Safety Plan has been accepted by the DEN Project Manager.
3. For projects enrolled in a ROCIP or OCIP, Contractor shall submit their Site Specific Safety Plan in accordance with the requirements and lead time outlined in the applicable R/OCIP Safety Manual and in accordance with Part 1.04.A of this Section.
4. For a project non enrolled in a ROCIP or OCIP, the Contractor shall submit the Contractor's Site Specific Safety Plan to the DEN Project Manager for review at least ten (10) calendar days before on-site construction begins. At a minimum, all applicable federal, state and local government requirements, and the following are to be included in the Contractor Site Specific Safety Plan:
5. The Contractor shall provide the following information for acceptance by the DEN Project Manager prior to the commencement of construction activities. The Site Specific Safety Plan must address all aspects listed below. If an item is not applicable, then this must be noted in the plan.
  - a. Name of the Contractor's safety representative.
  - b. If the Contractor is running multiple shifts or working more than (40) hours per week, the name of an assistant safety representative who can act in the absence of the site safety representative.
  - c. Twenty-four (24) hours per day emergency phone numbers of Contractor site management to be used in case of injury or accident. Provide at least four contacts.
  - d. How personnel will be handled who are unable to safely perform their duties, including how the Contractor will determine whether personnel are unable to safely perform duties. This may include the Contractor's disciplinary process and employee's physical capabilities to perform the work safely.
  - e. Injury and accident handling, including samples of the reporting form.
  - f. The type of safety training that will be provided to personnel to inform them of safe work procedures.
  - g. How daily audits and inspections will be performed to ensure compliance with the Contractor's Site Specific Safety Plan and current, applicable OSHA regulations.
  - h. Means of protecting employees working in trenches and excavations, including sloping and shielding.
    - 1) Soil classification will be considered as Type C when designing protective systems, unless the Contractor can prove to the satisfaction of DEN that the soil classification is otherwise. Soil classification change request shall be provided to the DEN Project Manager in writing. The decision of the DEN Project Manager will be provided to the Contractor in writing.
    - 2) The Contractor shall show how material shall be stored beside the excavation. Stored material shall include the excavated and backfilled material.
  - i. How and when equipment will be checked to see that it is safe, that all safety guards are in place, and that the equipment is being used for its designed purpose and within its rated capacity.

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- j. How and when all electric devices will be checked for proper grounding and insulation. Describe the methods that will be used for lock out tag out of electric systems that should not be energized.
- k. How trash and human organic waste will be disposed of.
- l. How snow and ice will be removed by the Contractor in the project area.
- m. How flammable materials will be stored and handled, and how any spills will be cleaned up and removed for disposal.
- n. What system will be used to prevent fires and, if fires do occur, who will be trained to fight them. In addition, what firefighting equipment will the Contractor have available and how will this equipment's condition be monitored.
- o. How materials will be received, unloaded, stored, moved, and disposed of.
- p. How personnel will be protected from falling when working at heights of 6 feet or more.
- q. How people working beneath the construction work will be protected.
- r. What will be done to protect personnel in case of severe weather.
- s. How adequate lighting will be provided and monitored.
- t. How air quality will be monitored to ensure that chemical exposures are below current, established OSHA Permissible Exposure Limits. How personnel will be protected if these limits are exceeded.
- u. How the safety of work platforms, man lifts, material lifts, ladders, shoring, scaffolding, etc., will be ensured relating to load capacity and the protection of personnel using or working around them.
- v. Where cranes will be set up and plans for each lift.
- w. The type of personal protective equipment that will be used to protect personnel from hazards. The minimum PPE requirements include hard hat, safety toe boots, safety glasses, proper hand protection, ANSI II vests for day work, and ANSI III vests and high visibility pants (gaiters may only be used airside) for night work.
- x. Procedures to ensure that welding and other hot work is performed safely.
  - 1) A hot work permit from the Denver Fire Department (DFD) will be required for all welding, soldering, cutting, and brazing and or other processes required by DFD on the project. Contractor will comply with all of the provisions in the permit.
- y. How compressed gases will be safely stored, handled, and used.
- z. Methods to ensure that personnel safely enter, work in, and exit confined spaces.
  - 1) All confined spaces on DEN property are considered permit required. A permit must be obtained from the DFD before Contractor personnel may enter a confined space. Contractors will comply with all provisions and requirements of this permit.
- aa. How the hazards of chemicals will be communicated to personnel, including the use of material safety data sheets and chemical labels.
- bb. Methods to ensure that forklifts and other powered industrial trucks are operated in a safe manner.
- cc. How an effective hearing conservation program will be used to protect personnel from high noise levels and prevent hearing loss.
- dd. How personnel will be protected from the effects of jet blast.
- ee. How hazards will be identified and corrected when reported.

**C. Safety submittal requirements**

- 1. For projects enrolled in a ROCIP or OCIP, Contractor shall submit all required safety submittals required by the Contract Documents, including the applicable ROCIP or OCIP Safety Manual including, but not limited to, high-hazard pre-task plans,

subcontractor pre-mobilization meetings, and incident reports. All Safety Submittals shall be submitted in accordance with Part 1.4.A of this Section unless otherwise modified by the Contract Documents. Contractor is responsible for reviewing the ROCIP or OCIP Safety Manual in its entirety and understanding full scope, timeline, and acceptance criteria outlined for the submittal requirements

**D. Additional safety submittals – ROCIP III**

1. The following is a representative list of submittals, other than the Site-Specific Safety Plan, that are required for relevant scopes of work or events covered under ROCIP III. This list is not all-inclusive and Contractor is responsible for reviewing the ROCIP III Safety Manual its entirety to determine if additional submittals are required for Contractor's scope of work. In addition, DEN may require additional safety pre-planning or pre-work meetings or information based on Contractor's scope of work and safety performance:
2. High-hazard Pre-Task Plans including:
  - a. Crane Operations
  - b. Elevated Work
  - c. Lock-Out Tag-Out
  - d. Trenching and Excavation
  - e. Confined Space
  - f. Hot Work
  - g. Traffic Control
  - h. Written Silica Exposure Control Program
  - i. Respiratory Protection Program
3. Preliminary Investigative Reports
4. Final Investigative Reports
5. Contractor's Monthly Safety Report

**E. Additional safety submittals – ROCIP IV**

1. The following is a representative list of submittals, other than the Site-Specific Safety Plan, that are required for relevant scopes of work or events covered under ROCIP IV. This list is not all-inclusive and Contractor is responsible for reviewing the ROCIP IV Safety Manual its entirety to determine if additional submittals are required for Contractor's scope of work. In addition, DEN may require additional safety pre-planning or pre-work meetings or information based on Contractor's scope of work and safety performance:
2. High-hazard Pre-Task Plans including:
  - a. Crane Operation
  - b. Elevated Work
  - c. Lock-Out Tag-Out
  - d. Utility Damage Prevention- Ground & Concrete Penetration
  - e. Trenching
  - f. Confined Space
  - g. Demolition
  - h. Hot Work
  - i. Traffic Control
  - j. Haul Routes
  - k. Silica Exposure and Slurry Control Program
  - l. Respiratory Protection Program

3. Subcontractor Safety Pre-Mobilization Documentation
4. Preliminary Investigative Reports
5. Final Investigative Reports
6. Contractor's Monthly Safety Report
7. Meeting Minutes and Attendance Log for Contractor's Supervisory Safety Meetings

**1.05 DEN PROJECT MANAGER'S REVIEW**

- A. Prior to the start of any work by contractor or subcontractor personnel, the Contractor shall provide the DEN Project Manager with a list of its personnel, subcontractor's personnel and other personnel the Contractor has requested to work at Denver International Airport, who have signified in writing that they have been briefed on, or have read and understand, the Contractor's Site Specific Safety Plan.

**1.06 AUDIT OF MANUAL COMPLIANCE**

- A. At its sole discretion, DEN may audit Contractor's submittals, including supporting documents that the contractor or its subcontractor is required to maintain or that would show compliance with the requirements of this Safety Manual. When documentation is requested, the Contractor must respond in the time outlined in the applicable ROCIP or OCIP Safety Manual, and where a timeline is not established, in no more than 7 days.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 IMPLEMENT CONTRACTOR'S SITE SPECIFIC SAFETY PLAN**

- A. Implement the approved Contractor's Site-Specific Safety Plan and other project safety plans as described in Part 1 of this Section, applicable Contract Safety Manual, all applicable regulations, Contract Documents, and in Section 011100 "Summary of Work."
- B. If the Project or an individual contractor or subcontractor experiences an OSHA DART or Total Recordable injury rate greater than 75 percent of the national average for all construction, the Contractor shall notify the DEN Project Manager and audit its safety procedures and submit a plan to reduce its rate(s).
- C. If at any time the OSHA DART or Total Recordable injury rates experienced by the Project or an individual contractor or subcontractor are 150 percent or more of the national average for construction, or exceeds \$0.50/labor hour, the Contractor shall notify the DEN Project Manager and immediately hire an independent safety professional at their own cost who shall audit the Contractor's procedures and operations and make a report of changes that the Contractor should implement to reduce the rate(s) including possible personnel changes.
  1. The report shall be submitted to the DEN Project Manager.
  2. The Contractor shall immediately begin implementing the recommendations of the independent safety professional.
  3. A weekly report shall be submitted by the Contractor to the DEN Project Manager on the status of the implementation of the recommendations.
  4. Failure to comply with these requirements is a basis to withhold a portion of progress payments or to terminate the Contract.

**3.02 SAFETY REQUIREMENTS FOR ALL CONSTRUCTION PROJECTS**

- A. For projects enrolled in a ROCIP or OCIP, Contractor will abide by all requirements specified in the Contract Documents, including the applicable ROCIP or OCIP Safety Manual. The applicable ROCIP or OCIP Safety Manual is incorporated in this Technical Specification for all enrolled projects.
- B. Contractor personnel, airport staff and field inspectors directly involved in DEN construction shall:
1. Be aware of the types of conditions, safety problems, and/or hazards identified each day at the airport. To ensure that all personnel are aware, daily meetings between management and supervisory personnel and their employees shall be scheduled prior to any work commencing on the shift.
  2. Inspect daily all work and/or storage areas for which the Contractor is responsible to be aware of current conditions.
  3. Promptly take all steps needed to remedy any unsafe or potentially unsafe condition. Coordinate with the DEN Project Manager to ensure immediate corrective action is undertaken.
- C. Housekeeping Requirements
1. Maintain the work site in a neat, orderly, and hazard-free manner in conformance with all federal, state, and local rules, codes, regulations, and orders, including all OSHA requirements, until Final Acceptance of the Work. Keep catwalks, underground structures, work site walks, sidewalks, roadways, and streets, along with public and private walkways adjacent to the work site, free from hazards caused by construction activities. All hard concrete, steel, wood, and finished walking surfaces shall be swept clean daily.
  2. Inspect those facilities regularly for hazardous conditions caused by construction activities. Maintain structures, grounds, storage areas and other areas of work site, including public and private properties immediately adjacent to work site, free from accumulations of waste materials caused by construction operations. Place waste materials in covered metal containers. Remove or secure loose material on open decks and on other exposed surfaces at the end of each workday or more often in a manner that will maintain the work site hazard free. Secure material in a manner that will prevent dislodgment by wind and other forces.
  3. Sprinkle waste materials with water or acceptable chemical palliative to prevent blowing of dust.
  4. Promptly empty waste containers when they become full and legally dispose of the contents at dumping areas off the City's property.
  5. Control the handling of waste materials. Do not permit materials to be dropped or thrown from structures.
  6. Immediately remove spillage of construction related materials from haul routes, work site, private property, public rights of way, or on the Denver International Airport site.
- D. Hazardous Material Controls
1. Store waste materials in properly labeled waste containers. This includes solid wastes, hazardous wastes, universal wastes, etc.
  2. Store volatile wastes in covered metal containers and remove those wastes from work site daily.
  3. Do not accumulate wastes that create hazardous conditions.

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**TECHNICAL SPECIFICATIONS**  
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4. If volatile and noxious substances are being used in spaces that are not naturally ventilated adequately, provide artificial ventilation.
  5. Hazard controls shall conform to the applicable federal, state, and local rules and regulations.
  6. Provide appropriate waste receptacles in all areas in which employees are working. Waste receptacles shall be kept covered at all times. All materials on site shall be anchored and covered to prevent any objects from becoming wind-borne.
- E. Safe Access
1. Maintain the work site to permit access by other City contractors as required and to allow access by emergency personnel.
- F. Aviation safety and continuity of operations is a primary consideration during construction at DEN. Activities shall be planned and scheduled to minimize disruption of normal aircraft and operation activities, including minimizing impacts to vehicular traffic. If the clearances and restrictions described in this plan cannot be maintained while construction is underway, action will be taken by the Contractor to perform Work at night or during periods of minimal aircraft or operational activity.
1. During performance of this Contract, the airport runways, taxiways, taxi lanes, and aircraft parking aprons shall remain in use by aircraft to the maximum extent possible, consistent with continual safety. Aircraft use of areas near the Contractor's Work will be controlled to minimize disturbance to the Contractor's operation. However, AIRCRAFT HAVE THE RIGHT OF WAY AT ALL TIMES. The Contractor shall not allow employees, subcontractors, suppliers, or any unauthorized persons to enter or remain in any airport area that would be hazardous to persons or to aircraft operations.
  2. Before commencement of construction activity, the Contractor, through coordination with the DEN Project Manager and DEN Operations, shall give notice using the NOTAM system of construction on the airfield. In addition, a NOTAM shall be issued for the completion of construction on the airfield.
- G. The Contractor shall take all necessary steps and precautions to mitigate the impact of hazardous conditions as they may relate to the Work. Potentially hazardous conditions which may occur during airport construction include, but are not limited to, the following:
1. Trenches, holes, or excavations on or adjacent to any active runway, taxiway, taxi lane, apron, or related safety areas.
  2. Unmarked/unlighted holes or excavations on or adjacent to any active runway, taxiway, taxi lane, apron, or related safety areas.
  3. Mounds or piles of earth, construction material, temporary structures, or other objects on or in the vicinity of any active runway, taxiway, taxi lane, apron or related safety, approach, or departure areas.
  4. Pavement drop-offs that would cause, if crossed at normal operating speeds, damage to aircraft that normally use the airport. The maximum drop-off is 3 inches per the most current version of FAA AC 150/5300.
  5. Vehicles or equipment (whether operating or idle) on any active runway, taxiway, taxi lane, apron or related safety, approach, or departure areas.
  6. Vehicles, equipment, excavations, stockpiles, or other materials that could impinge upon NAVAID-critical areas and degrade or otherwise interfere with electronic NAVAIDS or interfere with visual NAVAIDS facilities.
  7. Unmarked utility, NAVAIDS, weather service, runway lighting, underground power, or signal cables that could be damaged during construction.

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8. Objects or activities anywhere on or in the vicinity of an airport which would be distracting, confusing, or alarming to pilots during aircraft operations.
  9. Unflagged/unlighted low visibility items such as tall cranes, backhoes, scrapers, dump trucks, rollers, compactors, dozers and the ilk, in the vicinity of an active runway, taxiway, taxi lane, apron or related safety, approach, or departure areas.
  10. Dirt, debris, or other transient accumulations that temporarily obscure pavement markings or pavement edges or derogate the visibility of runway or taxiway markings or lighting or of construction and maintenance areas.
  11. Trash or other materials with foreign object damage (FOD) potential, whether on runways, taxiways, taxi lanes, aprons or in related safety areas.
  12. Failure to control vehicle, human and large animal access to, and nonessential nonaeronautical activities on, open aircraft movement areas.
  13. Failure to maintain radio communication between construction vehicles and air traffic control or other on-field communications facilities.
  14. Construction activities or material which could hamper Aircraft Rescue and Fire Fighting (ARFF) vehicle access from ARFF stations to all parts of the runway/taxiway system, runway approach and departure areas, or aircraft parking locations.
  15. Inadequate fencing or other marking to separate construction areas from open aircraft operating areas.
  16. Bird attractions such as edibles (food scraps, etc.), trees, brush, other trash, grass/crop seeding, or ponded water on or near the airport.
- H. Construction Area Marking: Temporary lighting, barricades, flagging, and flashers are required as shown on the plans and per the most current version of FAA AC 150/5370 Chapter 2 Section 220.b.(1)(2) Flag lines, traffic cones, flashers, edge lights, and/or signs shall be used as necessary:
1. To clearly separate all construction from other parts of an air operations area
  2. To identify isolated hazards, such as open manholes, excavations, areas under repair, stockpiled material, waste areas, etc.
  3. Vehicle and pedestrian access routes used for airport construction shall be controlled to prevent any unauthorized entry of persons, vehicles, or animals.
  4. Vehicle parking areas for Contractor employees shall be designated in advance to minimize traffic in open/active aircraft movement areas.
- I. Cables and Utilities:
1. Special attention shall be given to preventing unscheduled interruption of utility services and facilities. The location of all cables and utilities shall be identified prior to construction activities. In addition to following regulatory utility locate requirements, Contractor shall provide a 3rd party SUE or utility designation firm to perform a ground penetrating radar (GPR) sweep in all areas that will be excavated, or the ground penetrated, prior to work.
  2. There shall be coordination among the Contractor, the DEN Project Manager, DEN Operations, the FAA, the National Weather Service, utility companies, and any other appropriate entity or organization. NAVAIDS, weather service facilities, electric cables, and other utilities must be fully protected during the entire construction time.
  3. Power, communication, and control cables leading to and from any FAA NAVAIDS, weather service, and other facilities will be marked in the field by the appropriate individuals as identified in Section 011810 "Utilities Interface" for the information of the Contractor before any work in their general vicinity is started. Thereafter, through the

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entire duration of construction, utilities shall be protected from any possible damage.

4. At the intersection of expansion joints and centerline lighting circuits on taxiways and runways, the electrical conduit may be within the 21" portion of the Portland cement concrete pavement. Coordination with the DEN Project Manager's representative and the DEN Electrical Department is required for both the scheduling of an outage and the removal of conductors while cutting the joint.
- J. Employee Identification:
1. The Contractor will be required to conform to the specific requirements as outlined in Section 011420 "Security Requirements and Sensitive Security Information (SSI)" of the Contract documents.
- K. Radio Communications:
1. The Contractor's construction superintendent and flagger personnel shall be required to coordinate directly with the DEN Project Manager or designated Representative. Only the DEN Project Manager or designated Representative shall monitor transceiver radios tuned to the frequency for communications with DEN Operations and B Tower Control. Radios shall be used to obtain the proper clearance concerning the movement of equipment, trucks, etc., on the airfield. Further, any unusual occurrences in the flight pattern of approaching or departing aircraft shall be acknowledged by all concerned so that operation of the airport and the construction work can be carried out safely.
- L. Haul Routes Crossing Active Aircraft Operation Areas:
1. The Contractor shall provide a minimum of one (1) broom truck to continuously clean the surface of the active taxiway, taxi lane or apron of any foreign object debris (FOD) or other objectionable debris that may result from hauling activities. Additional broom trucks may be required to expedite the cleanup process. Opening the taxiway, taxi lane, or apron to aircraft operations shall only be approved after a visual inspection of the pavement surface by the DEN Airfield Operations Manager.
  2. The Contractor shall not work within the minimum of the following: 160 ft. of the centerline of an active taxiway, 310 ft. of the centerline of an active runway, or the minimum requirements of the FOD or Safety Zone unless otherwise noted in the Contract Documents and as approved in writing by the DEN Project Manager.
  3. All construction equipment and vehicles shall be flagged for high daytime visibility and if appropriate, lighted for nighttime operations. Vehicles that are not marked and lighted shall be escorted by a vehicle that is equipped with appropriate marking and lighting devices. Marking and lighting shall be in conformance with FAA AC 150/5210, current edition, or as outlined in Section 011430 "Vehicle and Equipment Permitting" of the Contract Documents.
  4. All Contractor and Subcontractor employees must be aware of the types of safety problems and hazards associated with aircraft operations and construction activities. All haul truck drivers must have current route maps with them in their vehicles.
- M. Airside Definitions:
1. Approach Surface: A surface longitudinally centered on the extended runway centerline and extending outward and upward from either a runway threshold or 200 feet behind a threshold. This surface is needed to define where unobstructed airspace above the runway begins.
  2. Notice To Airmen (NOTAM): A notice to the flying public (airmen) through FAA's NOTAM system. Normally initiated by message to the nearest FAA Flight Service Station. Issuance of the NOTAM will be coordinated through the DEN Project

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Manager and DEN Operations.

3. Object Free Area: A two-dimensional ground area surrounding runways, taxiways, and taxi lanes that is clear of objects, except for objects whose location is fixed by function.
4. Safety Area (see current version of AC 150/5300): A defined surface adjacent to runways, taxiways and taxi lanes prepared or suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot or excursion from the paved surface. Each safety area must be cleared and graded and have no potentially hazardous ruts, humps, depressions or other surface variations. Each safety area must be drained by grading or storm sewers to prevent water accumulation. East safety area must be capable under dry conditions of supporting snow removal and aircraft rescue and firefighting equipment and or supporting the occasional passage of aircraft without causing any damage to the aircraft. No objects may be located in any safety area, except for objects that need to be located in a safety area because of their function. These objects must be constructed, to the extent practical, on frangibly mounted structures of the lowest practical height, with the frangible point no higher than three (3) inches above grade.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013510**

**SECTION 013516****ALTERATION PROJECT PROCEDURES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes special procedures for alteration work.

**1.03 DEFINITIONS**

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the DOR's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by DOR.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep existing items that are not to be removed or dismantled.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

**1.04 COORDINATION**

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and

scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.

1. Schedule construction operations in sequence required to obtain best Work results.
  2. Coordinate sequence of alteration work activities to accommodate the following:
    - a. Owner's continuing occupancy of portions of existing building.
    - b. Owner's partial occupancy of completed Work.
    - c. Other known work in progress.
    - d. Tests and inspections.
  3. Detail sequence of alteration work, with start and end dates.
  4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
  5. Use of elevator and stairs.
  6. Equipment Data: List gross loaded weight, axle-load distribution, and wheelbase dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project buildings and site. Some work is near circulation patterns and adjacent to restricted areas. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Access to restricted areas may not be obstructed. Plan and execute the Work accordingly.

#### **1.05 PROJECT MEETINGS FOR ALTERATION WORK**

- A. Preliminary Meeting for Alteration Work: Before starting alteration work, DEN Project Manager will conduct meeting at Project Site.
1. Attendees: In addition to representatives of City, DEN Project Manager, DOR, and Contractor, a testing service representative and specialists shall be represented at the meeting.
  2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
    - a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Fire-prevention plan.
    - c. Governing regulations.
    - d. Areas where existing construction is to remain and the required protection.
    - e. Hauling routes.
    - f. Sequence of alteration work operations.
    - g. Storage, protection, and accounting for salvaged and specially fabricated items.
    - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
    - i. Qualifications of personnel assigned to alteration work and assigned duties.
    - j. Requirements for extent and quality of work, tolerances, and required clearances.
    - k. Embedded work such as flashings and lintels, special details, collection of waste,

protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from meeting.
- B. Coordination Meetings: Conduct coordination meetings specifically for alteration work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation meeting.
1. Attendees: In addition to representatives of the City, DEN Project Manager, DOR, and Contractor, each specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of alteration work activities shall be represented at these meetings. All participants at meeting shall be familiar with Project and authorized to conclude matters relating to alteration work.
  2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of alteration work. Include topics for discussion as appropriate to status of Project.
    - a. Alteration Work Subschedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
    - b. Schedule Updating: Revise Contractor's Alteration Work Subschedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
    - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Meeting for Alteration Work" Paragraph in this article and the following:
      - 1) Interface requirements of alteration work with other Project Work.
      - 2) Status of submittals for alteration work.
      - 3) Access to alteration work locations.
      - 4) Effectiveness of fire-prevention plan.
      - 5) Quality and work standards of alteration work.
      - 6) Change Orders for alteration work.
  3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

## 1.06 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to City that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain the City's property.
1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to where directed at Project site.

## 1.07 INFORMATIONAL SUBMITTALS

- A. Alteration Work Subschedule:
1. Submit alteration work subschedule within 30 days of date established for commencement of alteration work.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and

site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.

- C. Alteration Work Program: Submit 30 days before work begins.
- D. Fire-Prevention Plan: Submit 30 days before work begins.

### **1.08 QUALITY ASSURANCE**

- A. Specialist Qualifications: An experienced firm regularly engaged in specialty work similar in nature, materials, design, and extent to alteration work as specified in each Section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.
  - 1. Field Supervisor Qualifications: Full-time supervisors experienced in specialty work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on-site when specialty work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
    - a. Construct new mockups of required work whenever a supervisor is replaced.
- B. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.
- C. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.
  - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
  - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- D. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with City's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
- E. Safety and Health Standard: Comply with the current version of the ANSI/ASSE Safety and Health Program Requirements for Demolition Operations

### **1.09 STORAGE AND HANDLING OF SALVAGED MATERIALS**

- A. Salvaged Materials:
  - 1. Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
  - 2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
  - 3. Store items in a secure area until delivery to specified location.
  - 4. Transport items to the designated storage area indicated on Drawings.

5. Protect items from damage during transport and storage.
- B. Salvaged Materials for Reinstallation:
1. Repair and clean items for reuse as indicated.
  2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.
- C. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by DOR, items may be dismantled and taken to an approved, suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.
- D. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
  2. Secure stored materials to protect from theft.
  3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5°F or more above the dew point.
- E. Storage Space:
1. DEN Project Manager will arrange for limited on-site locations for free storage of salvaged material. This storage space does not include security and climate control for stored material.
  2. Arrange for off-site locations for storage and protection of salvaged material that cannot be stored and protected on-site.

### **1.10 FIELD CONDITIONS**

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs and preconstruction videotapes, as required by the DEN PM.
1. Comply with requirements specified in Section 013233 "Photographic Documentation."
- B. Discrepancies: Notify DEN Project Manager of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.
- C. DEN's Removals: Before beginning alteration work, verify in correspondence with DEN Project Manager that the Owner facilities requiring removal have been removed.
- D. Size Limitations in Existing Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PROTECTION**

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
1. Use only proven protection methods, appropriate to each area and surface being protected.
  2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
  3. Erect temporary barriers to form and maintain fire-egress routes.
  4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
  5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
  6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
  7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
  8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
  2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
1. Notify DEN Project Manager, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
  2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
  3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify DEN Project Manager immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.
1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by

sand or other materials resulting from alteration work.

2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- F. Existing Roofing: Prior to the start of work in an area, install roofing protection as indicated on drawings.

### **3.02 PROTECTION FROM FIRE**

- A. General: Follow fire-prevention plan and the following:
1. Comply with NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations requirements unless otherwise indicated. Perform duties titled "City's Responsibility for Fire Protection."
  2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
    - a. If combustible material cannot be removed, provide fire blankets to cover such materials.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:
1. Use of open-flame equipment is not permitted.
  2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
  3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
  4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
  5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
  6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
    - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
    - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
    - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
    - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
    - e. Maintain fire-watch personnel at each area of Project site until 60 minutes after conclusion of daily work.
- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire

risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire extinguisher and blanket use.

- D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.
  - 1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

### **3.03 PROTECTION DURING APPLICATION OF CHEMICALS**

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off City's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

### **3.04 GENERAL ALTERATION WORK**

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 013233 "Photographic Documentation."
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify DEN Project Manager of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
  - 1. Do not proceed with the work in question until directed by DEN Project Manager.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

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**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013516**

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**SECTION 014100**  
**REGULATORY REQUIREMENTS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section identifies primary compliance with the State's and the City and County of Denver's regulatory requirements including but not limited to:
1. City and County of Denver applicable agencies, including but not limited to its Department of Aviation, Community Planning and Development (including Building Department), Department of Transportation and Infrastructure, and Mayor's Executive Orders.
  2. Colorado Department of Public Health and Environment; and
  3. The standards that govern design and construction projects at Denver International Airport; and
  4. Any other regulatory requirements that govern or apply to the specific work.
- B. Construction shall be based on the latest edition of the referenced codes including additions and revisions thereto that are in effect at the time of Project bidding or Task Order pricing or GMP established whichever is latest, and as specifically related.

**1.03 RELATED SECTIONS**

- A. None.

**1.04 BUILDING CODE**

- A. All design and construction work shall be governed by the Building Code for the City and County of Denver, latest edition. This is based upon the International Building Code of the International Code Council with Denver Amendments to this code. Appendix N of the Denver Amendments addresses Construction of Airport Buildings and Structures.
1. This Contract shall be based on the most current published version of the ICC series as Amended by The City and County of Denver.

**1.05 DENVER BUILDING DEPARTMENT**

- A. For review and approval of all construction documents for compliance to the Denver building code:

Community Planning and Development  
201 W. Colfax Ave., Dept 205  
Denver, CO 80202  
Telephone: 720-865-2790

**1.06 DENVER FIRE DEPARTMENT**

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 014100 – REGULATORY REQUIREMENTS**

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**DENVER INTERNATIONAL AIRPORT**  
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- A. For review and approval of plans for compliance with the Denver Fire Department's requirements as they apply to the Denver International Airport:
- Denver Fire Department  
725 West Colfax Avenue  
Denver, CO 80204  
Telephone: 720-913-3474
- B. The Contractor is advised that the Denver Fire Department – Fire Prevention Bureau requires permitting for the following activities as they apply to the scope of work. The Contractor is responsible for obtaining the appropriate permits necessary to complete the work including, but not limited to, the work listed below. All costs associated with this permitting and policy compliance shall be the responsibility of the Contractor. The policies all reference the International Fire Code (IFC).
1. "Hot work", which is defined as the operation of any equipment or tool that creates sparks, hot slag, or radiant or convective heat as a result of the work. This includes, but is not limited to, welding, cutting, brazing, or soldering.
  2. Use and storage of compressed gas for both temporary storage and permanent facility installation. This includes, but is not limited to, flammable gas (excluding propane-LPG), oxidizer (including oxygen), and inert and/or simple asphyxiates.
  3. Tank installation, which includes aboveground storage tanks (AST) and underground storage tanks (UST) for both temporary tanks and permanent facility installations.
  4. Access to and work within areas that are designated as confined spaces.
- C. In addition to the above permits, the Denver Fire Department may require other permits that are associated with the specific work in the Contract Documents. Policies provided by the Denver Fire Department are meant to provide basic information for the most common conditions and situations. In any given occupancy, many other Uniform Fire Code requirements may be enforced. These should be addressed with the Denver Fire Department before construction begins and during construction with premise inspection(s).
1. The Fire Prevention Bureau web site is [denfpb@denvergov.org](mailto:denfpb@denvergov.org)

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PERMITS AND CERTIFICATIONS**

- A. The Contractor shall maintain records on site of all permits acquired by federal, state, and local agencies. Posting of permits shall conform to requirements of the respective agencies.
- B. At the completion of any inspection by other agencies, the Contractor shall forward copies of the status of the inspection and copies of any approved or "signed-off" inspections by the respective agencies to the DEN Project Manager.
- C. At the time of request for Substantial Completion, the Contractor shall forward to the DEN Project Manager all permits approved by the respective agencies.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 014100 – REGULATORY REQUIREMENTS**

**DENVER INTERNATIONAL AIRPORT  
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**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014100**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 014100 – REGULATORY REQUIREMENTS**

**DENVER INTERNATIONAL AIRPORT  
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**SECTION 014210****REFERENCED MATERIAL****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 REFERENCED MATERIAL**

- A. City and County of Denver, Department of Aviation, Standard Specification for Construction, General Contract Conditions
- B. The following documents may be available for examination at the Owner's offices unless otherwise noted. The referenced material and documents are not part of the Contract Documents unless otherwise specified.
1. Environmental Impact Statement (EIS).
  2. Geotechnical Reports:
    - a. Borings, other field and laboratory explorations, and investigations have been made to indicate subsurface materials at particular locations. Explorations and investigations conducted by designers and their subconsultants are solely for the purpose of study and design.
    - b. The subsurface exploration and investigation information is presented or made available to indicate some of the conditions that may be encountered during construction and is offered as supplementary information only. Geotechnical information presented in the referenced material represents the opinion of soils consultants as to the character of the materials encountered. Subsurface information was directly obtained only at the specified location and necessarily indicates subsurface conditions only at the respective plan location, depths penetrated and only at the time of the exploration.
    - c. Neither the City nor the Designers assume any responsibility whatever in respect to the sufficiency or accuracy of borings made, or of the logs of test borings, or of other investigations, or of the interpretations made thereof, and there is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations are representative of those existing throughout such area, or any part thereof, or that unforeseen developments may not occur. It is expressly understood that the making of deductions, interpretations, and conclusions from all of the accessible factual information, including the nature of the materials to be excavated, the difficulties of doing other work affected by the geology, groundwater elevations and other subsurface conditions at the site of the Work are the Contractor's sole responsibility.
    - d. Information derived from inspection of logs of borings, topographic maps, technical memorandum, reports, or plans showing information of the subsurface of site conditions will not relieve the Contractor from any risk or from properly examining the site and making such additional investigations as the Contractor may elect or from properly fulfilling all the terms of the Contract Documents.
  3. Available Conceptual Utility and Drainage Reports.
  4. DEN Digital Facilities and Infrastructure (DFI) Design Standards Manual (DSM)
  5. Woolpert, Inc. Report - "A Low Distortion Projection for Denver International Airport

(DEN)", dated 12/10/2010.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014210**

## SECTION 014220

### ABBREVIATIONS AND SYMBOLS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Edit and/or insert items in list below as required for Project.

##### 1.02 REFERENCE LIST

- A. Documents published by the following agencies may be referenced within these Contract Documents to define the quality of materials, equipment, workmanship, and other features of Work. Unless otherwise stated, the reference documents shall be of the latest edition as of the date of the Advertisement for Bids.
- B. Wherever used in the Contract Documents, the following abbreviations will have the meanings listed:

<b>Abbreviation</b>	<b>Definition</b>
AALA	American Association of Laboratory Accreditation
AAN	American Association of Nurserymen
AAO	Affirmative Action Officer
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AFI	Air-Filter Institute
AGTS	Automated Ground Transportation System
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
APEN	Air Pollution Emission Notes
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWPA	American Wood Preserver's Association
AWS	American Welding Society
AWWA	American Water Works Association
BID	Building Inspection Division, Department of Public Works
BIM	Building Information Modeling

**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 014220 - ABBREVIATIONS AND SYMBOLS**

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<b>Abbreviation</b>	<b>Definition</b>
CAR	Corrective Action Report
CCD	City and County of Denver
CCR	Contractor Change Request
CCRL	Cement Concrete Reference Laboratory
CD	Change Directive
CDOH	Colorado Department of Highways or Colorado Department of Health
CDOT	Colorado Department of Transportation
CMEC	Concrete Materials Engineering Council
CN	Change Notice
CO	Change Order
COE	Corps of Engineers
CPM	Critical Path Method
CR	Change Request
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DEN	Denver International Airport
DFD	Denver Fire Department
DOT	United States Department of Transportation
DOR	Designer of Record
DWB	Denver Water Board
EEO	Equal Employment Officer or Equal Employment Opportunity
EIA	Electronics Industry Association
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FM	Factory Mutual Association
FS	Federal Specifications (U.S. General Services Administration)
GCC	General Contract Conditions
GIS	Geographic Information Systems
GMP -	Guaranteed Maximum Price
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code (published by ICC)
IBR	Institute of Boiler and Radiator Manufacturer's
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMC	International Mechanical Code (published by ICBO)
IPC	International Plumbing Code (published by ICBO)
ISA	Instrument Society of America
ITA	Independent Testing Agency
MIL	Military Specifications (Naval Publications and Forms Center)
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
MUTCD	Manual of Uniform Traffic Control Devices
NAAB	National Association of Air Balance
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards (now called National Institute of Standards and Technology)
NEC	National Electric Code (NFPA 70)
NECA	National Electric Contractors Association
NEMA	National Electrical Manufacturer's Association

**TECHNICAL SPECIFICATIONS**  
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<b>Abbreviation</b>	<b>Definition</b>
NESC	National Electrical Safety Code
NFC	National Fire Code (as published by NFPA)
NFPA	National Fire Protection Association
NICET	National Institute for the Certification of Engineering Technologies
NIST	National Institute of Standards and Technology
NGS	National Geological Survey
NLMA	National Lumber Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NRMCA	National Ready Mix Concrete Association
NTP	Notice to Proceed
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDM	Precedent Diagram Method
PS	Product Standard of NIST (U.S. Department of Commerce)
PM	Project Manager
PMT	Project Management Team
PXP	Project Execution Plan
QA	Quality Assurance
QC	Quality Control
RFI	Request for Information
RTD	Regional Transportation District
SC	Special Contract Condition
SDI	Steel Door Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPWC	Standard Specifications for Public Works Construction
TCP	Traffic Control Plan
TSA	Transportation Security Administration
UL	Underwriters Laboratories, Inc.
USC	United States Code
WBS	Work Breakdown Schedule

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014220**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 014225****REFERENCE STANDARDS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section contains a summary of industry-accepted and recognized standards published by trade associations, government, and institutional organizations that are referred to in the various Sections of these specifications or elsewhere in the Contract Documents.
- B. Standards listed herein are included in the Contract Documents by this reference and become a part of the Contract Documents to the same extent as though included in their entirety unless specific limitations are noted in the individual specifications Sections.
- C. Listings of reference standards include name and address of the organization publishing the standard, and the full name and designator of each of the standards referenced herein.
- D. If a publication date or edition number is listed with the reference standard, that publication date or edition number shall apply. Otherwise, the publication date or edition number in effect at the Contract date shall apply.
- E. Inclusion of reference standards herein does not make the DEN Project Manager an agent of the publishing agency, nor does it obligate the DEN Project Manager to perform inspections required by or to enforce rules or regulations contained in the reference standards.

**1.03 SCHEDULE OF REFERENCE STANDARDS**

- A. American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, NW, Suite 249, Washington, DC 20090:
  - 1. AASHTO M 36–Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
  - 2. AASHTO M216–Standard Specification for Lime for Soil Stabilization.
  - 3. AASHTO T26–Standard Method of Test for Water to be Used in Concrete.
  - 4. AASHTO T84–Specific Gravity and Absorption of Fine Aggregate.
  - 5. AASHTO T85–Specific Gravity and Absorption of Coarse Aggregate.
  - 6. AASHTO T103–Soundness of Aggregates by Freezing and Thawing
  - 7. AASHTO T219–Standard Methods of Testing Lime for Chemical Constituents and Particle Sizes.
- B. American Concrete Institute (ACI) 38800 Country Club Drive, Farmington Hills, MI 48331
  - 1. ACI 211.1–Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
  - 2. ACI 301–Specifications for Structural Concrete for Buildings.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 014225 – REFERENCE STANDARDS**

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3. ACI 304–Recommended Practices for Measuring, Mixing, Transporting and Placing Concrete.
  4. ACI 304.2R–Placing Concrete by Pumping Methods.
  5. ACI 305R–Hot Weather Concreting.
  6. ACI 306R–Cold Weather Concreting.
  7. ACI 318–Building Codes Requirements for Structural Concrete
    - a. Reference to ACI 318 may be limited to more stringent requirements of local building code.
- C. American Society for Testing and Materials (ASTM), International 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428:
1. ASTM A 27–Mild to Medium Strength Carbon - Steel Casting for General Application.
  2. ASTM A 36–Structural Steel.
  3. ASTM A 47–Malleable Iron Castings.
  4. ASTM A 82—Specification for Steel Wire, Plain, for Concrete Reinforcement: Replaced by A1064
  5. ASTM A 123–Hot-dip Galvanizing.
  6. ASTM A 184–Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
  7. ASTM A 185—Specifications for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement: Replaced by A1064
  8. ASTM A 283–Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.
  9. ASTM A 615–Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  10. ASTM A 706–Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
  11. ASTM C 25–Method for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime.
  12. ASTM C29–Unit Weight and Voids in Aggregate
  13. ASTM C 31–Methods of Making and Curing Concrete Test Specimens in the Field.
  14. ASTM C 33–Specification for Concrete Aggregates.
  15. ASTM C 39–Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  16. ASTM C 42–Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  17. ASTM C 76–Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  18. ASTM C 88–Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
  19. ASTM C 94–Specification for Ready Mixed Concrete.
  20. ASTM C 109–Compressive Strength of Hydraulic Cement Mortars
  21. ASTM C 110–Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone.

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**TECHNICAL SPECIFICATIONS**  
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22. ASTM C 117–Materials Finer than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing.
23. ASTM C 131–Resistance of Abrasions of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
24. ASTM C 136–Method for Sieve Analysis of Fine and Coarse Aggregates.
25. ASTM C 138–Unit Weight, Yield, and Air Content of Concrete.
26. ASTM C 143–Test Method for Slump of Hydraulic – Cement Concrete
27. ASTM C 150–Specification for Portland Cement
28. ASTM C 171–Specification for Sheet Material for Curing Concrete.
29. ASTM C 172–Method of Sampling Fresh Concrete.
30. ASTM C 173–Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
31. ASTM C 231–Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
32. ASTM C 260–Specification for Air Entraining Admixture for Concrete.
33. ASTM C 309–Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
34. ASTM C 443–Joints for Concrete Pipe and Manholes, using Rubber Gasket
35. ASTM C 494–Specification for Chemical Admixtures for Concrete.
36. ASTM C 595–Blend Hydraulic Cements.
37. ASTM C 618–Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete
38. ASTM C 655–Reinforced Concrete D Load Culvert, Storm Drain, and Sewer Pipe.
39. ASTM C 789—Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers: Replaced by C1433
40. ASTM C 803–Test Method for Penetration Resistance of Hardened Concrete.
41. ASTM C 805–Test Method for Rebound Number of Hardened Concrete.
42. ASTM C 977–Specification for Quicklime and Hydrated Lime for Soil Stabilization.
43. ASTM D 75–Sampling Aggregate.
44. ASTM D 422–Test Method for Particle Size Analysis of Soils.
45. ASTM D 516-88–Standard Test Method for Sulfate Ions in Water.
46. ASTM D 693—Crushed Stone, Crushed Slag and Crushed Gravel for Dryer Water-Bound Macadam Base Courses and Bituminous Macadam Base and Surface Courses of Pavements: Withdrawn
47. ASTM D 698–Laboratory Compaction Characteristics of Soil using Standard Effort
48. ASTM D 751–Test Method for Coated Fabrics
49. ASTM D 1556–Test Method for Density of Soil in Place by the Sand-Cone Method.
50. ASTM D 1557–Laboratory Compaction Characteristics of Soil using Modified Effort
51. ASTM D 1682—Ultraviolet Resistance Grab Tensile Strength Grab Tensile Elongation Toughness: Replaced by D5034 and D5035
52. ASTM D 1751–Specification for Preformed Expansion Joint Fillers for Concrete

**TECHNICAL SPECIFICATIONS**  
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Paving and Structural Construction.

53. ASTM D 1752–Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
  54. ASTM D 2167–Test Method for Density of Soil in Place by the Rubber-Balloon Method.
  55. ASTM D 2216–Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures.
  56. ASTM D -79 (2011) Hydroxypropyl Methylcellulose
  57. ASTM D 2419–Sand Equivalent Value of Soils and Fine Aggregate.
  58. ASTM D 2487–Test Method for Classification of Soils for Engineering Purposes.
  59. ASTM D 2922—Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Method: Replaced by D6938
  60. ASTM D 3017—Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth): Replaced by D6938
  61. ASTM D 3665–Random Sampling of Paving Materials.
  62. ASTM D 4253–Test Method for Maximum Index Density of Soils Using Vibratory Table.
  63. ASTM D 4318–Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  64. ASTM D 4397–Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications.
  65. ASTM D 4546–Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils.
  66. ASTM E 329–Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
  67. ASTM F 477–Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
  68. ASTM F 758–Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage.
- D. American Welding Society (AWS), 550 NW LeJeune Road, Miami, FL 33135 AWS Code for Welding in Building Construction (Structural Welding Code).
- E. Concrete Reinforcing Steel Institute (CRSI) 933 N. Plum Grove Road, Schaumburg, IL 60195, (312) 490-1700:
1. Manual of Standard Practice.
- F. Colorado Department of Transportation (CDOT) Division of Administration, Office of Bid Plans, 4201 E. Arkansas Avenue, Denver, CO 80222:
1. Standard Specifications for Road and Bridge Construction (latest edition) Colorado Standard Plans, M&S Standards.
- G. Federal Highway Administration (FHWA) Superintendent of Documents, US Government Printing Office, Washington DC, 20402:
1. Manual of Uniform Traffic Control Devices (latest edition).

**PART 2 - PRODUCTS (NOT USED)**

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**TECHNICAL SPECIFICATIONS  
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**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014225**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 014230****DEFINITIONS AND CONVENTIONS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section contains a list of definitions of words or phrases and grammatical or contextual conventions commonly used in these Contract Documents.

**1.03 DEFINITIONS**

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. Alphabetical Listing of Definitions:
1. As indicated: Shown on the drawings by graphic indication, notes, or schedules, or written in the specifications or elsewhere in the Contract Documents.
  2. As directed, as approved, as requested: Unless otherwise indicated, these terms imply "by the DEN Project Manager" and require that an instruction be obtained by the Contractor from the DEN Project Manager.
  3. Concealed: Embedded in masonry, concrete, or other construction; installed in furred spaces; within double partitions or hung ceilings; in trenches; in crawl spaces or in enclosures.
  4. Ensure: To make certain in a way that eliminates the possibility of error.
  5. Exposed: Not installed underground or "concealed" as defined above.
  6. Furnish or Provide: To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
  7. Indicated, Shown, or Noted: As depicted on drawings or specifications.
  8. Install: To erect, mount and connect complete with related accessories.
  9. Or equal, or approved equal: Refers to products which, in the opinion of the DEN Project Manager, are similar in all respects to products specified by proprietary brand name. Refer to Section 012510 "Substitutions" for procedures for submittal of proposed substitutions.
  10. Rework: To repair existing items or work required to be removed and replaced in order to accomplish the Work in accordance with the Contract Documents.
  11. Related Work: Includes, but not necessarily limited to, mentioned work associated with, or affected by, the Work specified.
  12. Reviewed, Satisfactory, Accepted, or Directed: Assumes by or to the DEN Project Manager.
  13. Similar, or Equal: Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
  14. Supply: To purchase, procure, acquire and deliver complete with related accessories.

15. Unless Otherwise Indicated and Unless Otherwise Noted: General note to perform work as indicated or shown on drawings or in specifications unless specifically directed otherwise elsewhere in the Contract Documents; may be abbreviated "U.O.N.", "U.O.I.", or "U.N.O."

C. BIM Model Definitions:

1. Building Information Model (BIM): BIM is a digital representation of the physical and functional characteristics of the Project and is referred as a Model(s), which term may be used to describe a Model Element, a single Model or technology used to create the Model.
2. Design Model: A Model that has reached the stage of completion that would customarily be expressed by an architect or engineer in two-dimensional Construction Documents.
3. Construction Model: The equivalent of shop drawing and other information useful to construction. A model that consists of data imported from a "Design Model or", if none exist, from a designer's "Construction Document".
4. Federated Model: Distinct component models "linked" together in such a manner that the linked data sources so not lose the indent or integrity by being so linked.
5. Level of Development (LoD): LoD describes the level of completeness to which a Model Element is developed.
6. Model Element: Is a portion of the BIM representing a component system or assembly within a building or building site.
7. Model Element Author: The party responsible for developing the content of a specific Model Element to the LoD for a particular phase of the Project.

#### **1.04 BIM REFERENCE STANDARDS**

- A. Refer to the DEN BIM Design Standard Manual (DSM) for the proposed minimum requirements of the BIM Execution Plan. The execution plan shall be further developed jointly with DEN and the Contractor to specifically address the administrative steps necessary to provide comprehensive BIM system before during and after construction.

#### **1.05 CONVENTIONS**

A. Specifications Format:

1. In order to standardize the location of information in the Contract Documents, the specifications generally are organized in one or more of the following formats:
  - a. The "MASTERFORMAT" 2011 Edition published by the Construction Specifications Institute.
  - b. The Standard Specifications for Road and Bridge Construction published by CDOT.
  - c. The alphanumeric system as published by the FAA.

B. Organization of Drawings and Specifications:

1. Organization of the specifications into divisions and sections, and arrangement or numbering of drawings is intended solely for the convenience of the Contractor in the Contractor's responsibilities to divide the Work among subcontractors or to establish the extent of work to be performed by any trade.
2. Neither the City nor the DEN Project Manager assume any liability arising out of jurisdictional issues or claims advanced by trade organizations or other interested parties based on the arrangement or organization of drawings or specifications.

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**C. Gender and Number:**

1. For convenience and uniformity, parties to the Contract, including the City, Contractor, and DEN Project Manager, and their subcontractors, suppliers, installers, consultants or other interested parties are referred to throughout the Contract Documents as if masculine in gender and singular in number. Such reference is not intended to limit the meaning of the Contract Documents to the masculine gender or singular number.

**D. Singular vs. Plural:**

1. Materials, products, equipment, or other items of work referred to in the singular shall be construed as plural where applicable by the intent of the Contract Documents and shall not limit quantities to be provided by the Contractor.

**E. Imperative Mood:**

1. Specifications and notes on the drawings or elsewhere in the Contract Documents are generally written in the imperative mood as instructions to the Contractor, whether the Contractor is specifically addressed or not.

**F. References to Subcontractors or Trades**

1. References to subcontractors, trades or other entities, which are not parties to the Contract, shall be construed as meaning the Contractor whose responsibility it shall be to divide the Work among subcontractors or trades. Such references are used as a matter of convention, and are not intended to preclude or direct the Contractor's responsibility to divide the Work.

**G. Abbreviations**

1. A list of abbreviations used in the Contract Documents is included in Technical Specifications Section 014220 "Abbreviations and Symbols"; an abridged list of abbreviations used on the drawings is included with the drawings.
2. Abbreviations are believed to be those in general use in the construction industry. Contact the DEN Project Manager for clarification of abbreviations for which the meaning is not clear.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014230**

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**SECTION 014320****DEN QUALITY ASSURANCE FOR FAA FUNDED PROJECTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Refer to Title 17 – Inspection and Defects in the General Contract Conditions, 2011 Edition.
- C. ASTM standard practices and specifications testing including, but not limited to, the following:
  - 1. ASTM C 1077: Standard Practices for Laboratory Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
  - 2. ASTM D 3666: Road & Paving Materials
  - 3. ASTM D 3740: Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
  - 4. ASTM E 329: Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction
  - 5. ASTM E 543: Determining the Qualifications of Nondestructive Testing Agencies.
- D. Other:
  - 1. Standard testing practices for other disciplines.

**1.02 SUMMARY**

- A. This Section identifies Denver International Airport (DEN) inspection activities to be performed by inspectors employed by DEN and working under the direction of the DEN Project Manager.

**1.03 QUALITY ASSURANCE**

- A. Inspection and tests, conducted by persons or agencies, including DEN, other than the Contractor, shall not in any way relieve the Contractor of the Contractor's responsibility and obligation to meet all requirements of Contract Documents and the referenced standards.
- B. The inspection and approval of Work by other agencies above does not constitute inspection or acceptance of Work required by DEN. The Contract Documents may contain requirements more stringent than Denver Building Inspection Division or other code agency requirements. The City will perform all acceptance testing.
- C. The Contractor will employ the services of a Material Testing Agency in conformance with Section 014525 "Material Testing Agency" to perform acceptance testing on all earthwork and earthwork related work items. DEN Quality Assurance (QA) program will monitor all tests performed by the Contractor's Material Testing Agency and must be present on site during all acceptance testing and inspections.
- D. The City may employ the services of a Testing Agency (TA), which will perform all acceptance testing.

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- E. Laboratory and field-testing requirements to be conducted by the TA for materials and construction on this project are included in the appropriate Contract Documents. Where the Contract Documents reference the CDOT Standard Specifications for Road and Bridge Construction, the references shall also mean CDOT Field Materials Manual for schedule of tests unless otherwise stated. As a minimum, the TA described in this Section shall perform all applicable tests including the sampling and acceptance testing. In the event of such a conflict between the schedule and a specification in the Contract Documents, the more comprehensive testing shall govern unless otherwise noted.
- F. Inspections and tests conducted by the TA shall not in any way relieve the Contractor of the Contractor's responsibility and obligation to meet the requirements of all Contract Documents and referenced standards. Employment of the City's TA does not relieve the Contractor of providing the required Quality Control program.
- G. When inspections or tests by the TA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor.
- H. Samples will only be considered if taken at random.
- I. The Contractor is obligated to correct any item deemed deficient at no additional cost to the City.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014320**

**SECTION 014520****CONTRACTOR QUALITY CONTROL PROGRAM - FAA****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Contractor shall establish, provide and maintain an effective Quality Control Program that details the methods and procedures that will be taken to ensure that all materials and completed construction required by this Contract conform to Contract Documents and any other requirements, whether manufactured by the Contractor or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the Contract Documents, the Contractor shall assume full responsibility for accomplishing the stated purpose.

**1.03 LEVEL OF CONTROL**

- A. The intent of this Section is to explain the Contractor's need to establish a necessary level of control that will:
1. Adequately provide for the production of acceptable quality materials.
  2. Manager that the Contract requirements are being met.
  3. Allow the Contractor as much latitude as possible to develop the Contractor's own standards of control.

**1.04 REQUIREMENTS**

- A. The Contractor shall be prepared to discuss at the Preconstruction Conference, the Contractor's understanding of the quality control requirements. A written Quality Control Plan shall be submitted to the DEN Project Manager no later than ten (10) days after the Notice to Proceed. The Contractor shall not begin any construction, production or off-site fabrication of materials to be incorporated into the completed work until the Quality Control Plan has been reviewed and approved by the DEN Project Manager. No partial payment will be made for work or materials subject to specific quality control requirements until the Quality Control Plan has been reviewed and approved by the DEN Project Manager.
- B. The quality control requirements contained in this Section and elsewhere in the Contract Documents are in addition to and separate from the acceptance testing requirements. Certain acceptance testing requirements as noted in the specifications are also the responsibility of the Contractor.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 QUALITY CONTROL PROGRAM**

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**TECHNICAL SPECIFICATIONS**  
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- A. General Description: The Contractor shall establish a Quality Control Program to perform inspection and testing of all items of Work required by the Contract Documents, including those performed by subcontractors. This Quality Control Program shall ensure conformance to applicable specifications and plans with respect to materials, workmanship, construction, finish, and functional performance. The Quality Control Program shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the Contract Documents in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of quality control.
- B. Quality Control Plan: The following Quality Control Plan shall be submitted within ten (10) days of receiving the Administrative Notice to Proceed (NTP) in a MS Word or MS Excel format that can easily be incorporated into the FAA Construction Management Plan. The Contractor shall describe the Quality Control Program in a written plan. The Quality Control Plan shall provide a general description of minimum quality control monitoring required to be performed for each specification division until Final Acceptance by DEN.
1. The Quality Control Plan shall address and establish controls and documentation to ensure that only items or materials that have been accepted through successful inspection are used or installed. Identification and traceability of construction materials shall be provided throughout all inspections, test activities and records. For stored items, provisions shall be made for the control of the item/material identification, consistent with the expected duration and type of storage.
  2. The Quality Control Plan shall describe the methodology of monitoring, testing and exercising of all equipment, valves and/or assemblies to ensure the Work installed is in proper working order.
  3. In addition, the Quality Control Plan shall be organized to address, as a minimum, the following items:
    - a. Quality control organization and personnel.
    - b. Inspection requirements.
    - c. Quality control testing plan.
    - d. Documentation of quality control activities.
    - e. Requirements for corrective action when quality control and/or acceptance criteria are not met.
    - f. Testing Agencies Certifications, personnel certifications, equipment lists, test forms, report samples and forms, frequency of tests, specification references, and specification standards.
    - g. Acceptance tests required and methods of quality control for each activity included in the Contract Documents.
  4. The Contractor is encouraged to add any additional elements to the Quality Control Plan that he/she deems necessary to adequately control all production and/or construction processes required by this Contract.

### **3.02 QUALITY CONTROL ORGANIZATION**

- A. The Contractor's Quality Control Program shall be implemented by the establishment of a separate quality control organization. An organizational chart shall be developed to show all quality control personnel and how these personnel integrate with other management/production and construction functions and personnel.
1. The organizational chart shall identify all quality control staff by name and function and shall indicate the total staff required to implement all elements of the Quality Control Program, including inspection and testing for each item or work. If necessary, different technicians can be utilized for specific inspection and testing functions for different items of work. All personnel used for implementation of all or part of the

Quality Control Program shall be subject to the qualification requirements of this Section. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

- B. The quality control organization shall consist of the following minimum personnel:
1. Quality Control Manager:
    - a. The Quality Control Program shall be administrated by a Quality Control Manager. The Quality Control Manager shall be a full-time employee of the Contractor or a consultant engaged by the Contractor. The Quality Control Manager shall have a minimum of five (5) years of experience in airport and/or highway construction and shall have had prior quality control experience on a project of comparable size and scope as this Contract.
    - b. Additional qualifications for the Quality Control Manager shall include the following requirements:
      - 1) A licensed professional engineer with a minimum of five (5) years of airport or highway grading and drainage paving, field and laboratory testing, and quality control experience acceptable to the DEN Project Manager, or,
      - 2) A technician certified at Level III or IV by the National Institute for Certification in Engineering Technologies (NICET) for Construction Materials, Highway Materials, Highway Construction or five (5) years of highway and/or airport paving experience in all fields of work included in the scope of work and acceptable to the DEN Project Manager.
      - 3) Submit the following documentation to the DEN Project Manager for review:
        - a) A current resume including the individual's experience and qualifications.
        - b) Copy of current PE registration and/or all applicable certifications.
        - c) Four (4) references for work on projects completed within past five (5) years, including names, current organization, and telephone numbers.
    - c. The Quality Control Manager shall have full authority to institute any and all actions necessary for the successful implementation of the Quality Control Program to ensure compliance with the Contract Documents. The Quality Control Manager shall report directly to a responsible officer of the construction firm. The Quality Control Manager shall be on-site for a minimum of forty (40) hours per week during all production and shall be released from full-time duties only after written permission from the DEN Project Manager.
  2. Electrical Quality Control Manager: Depending on the project's scope of work, the Contractor shall provide a dedicated, full-time Electrical Quality Control Manager. The Electrical Quality Control Manager shall have no other responsibilities other than overall electrical quality control. The Electrical Quality Control Manager shall be a master electrician with a minimum of five (5) years electrical airfield construction experience at a commercial carrier airport. The Electrical Quality Control Manager shall be a Certified Senior Technician.
    - a. The Quality Control personnel:
      - 1) Shall be familiar with and prove proficiency in all aspects of inspections and testing he/she is supervising.
      - 2) Shall not perform any testing or inspection he/she is not certified to perform.
      - 3) Shall be subject to the approval of DEN Project Manager.
      - 4) Shall not report or be part of the production team on the Project.
  3. Quality Control Inspection Technicians: A sufficient number of Quality Control Inspection Technicians necessary to adequately implement the Quality Control Program shall be provided by the Contractor. The Quality Control Inspection Technicians shall have the authority to bring the Work into conformance with Contract requirements including stopping non-conforming work in progress. A document signed by an officer of the Contractor shall convey and acknowledge the Inspector's

- authority. Inspection personnel shall be engineers, engineering technicians, or experienced craftsman with the following qualifications:
- a. Engineer-in-training with minimum two (2) years of airport/highway grading experience acceptable to the DEN Project Manager.
  - b. An individual with 3 years of highway and/or airport grading experience acceptable to the DEN Project Manager, with a Bachelor of Science degree in Civil Engineering, Civil Engineering. Technology or Construction.
  - c. The Quality Control personnel:
    - 1) Shall be familiar and prove proficiency in all aspects of inspections and testing he or she is supervising.
    - 2) Shall not perform any inspection he/she is not certified to perform.
    - 3) Shall be subject to the approval of DEN Project Manager.
    - 4) Shall not report or be part of the production team on the Project.
  - d. The Quality Control Inspection Technicians shall report directly to the Quality Control Manager and shall perform the following functions:
    - 1) Inspection of all materials, construction, plant and equipment for conformance to the Technical Specifications, and as required by Article 3.3 below
    - 2) Performance of all quality control tests as required by the Technical Specifications and Article 3.4 of this Section.
- C. If the DEN Project Manager determines that the Quality Control Manager or any of the Quality Control Manager's authorized support personnel are not effectively enforcing or performing the Quality Control requirements specified in the Contract, the DEN Project Manager will, in writing, require the Contractor to remove and replace such personnel from the Project at no cost to the City. No further work will be performed by the Contractor until an acceptable replacement for the replaced personnel is approved by the DEN Project Manager.
- D. Staffing Levels: The Contractor shall provide sufficient qualified quality control personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the Work, separate plant and field testing technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The Quality Control Plan shall state where different technicians will be required for different work elements. Should the DEN Project Manager determine that staffing levels are not sufficient to ensure compliance with the Quality Control Plan and Contract Documents, the Quality Control Manager shall take steps to bring staffing levels to an acceptable level.
- E. Suppliers and Subcontractors: The Quality Control Plan shall include a list of suppliers and subcontractors. The list shall include items to be supplied by each supplier and/or subcontractor and shall identify work to be performed by each subcontractor. The list shall be updated and submitted as required.
- F. Emergency Contact Information: Provide the name, company, title, work phone number, home phone number, and other means of contact for at least four (4) individuals. The individuals can be associated with production and/or quality control. The Emergency Contact list shall be revised in the event there is any change in any of the information and forwarded to the DEN Project Manager and DEN Maintenance Control (303-342-2800). The Emergency Contact list shall also include the project number, title and date of issue.

### **3.03 INSPECTION REQUIREMENTS.**

- A. The Contractor shall utilize the following six-point inspection plan to ensure the conformance of the Work performed by the Contractor meets the requirements of the Contract Documents, the referenced codes and standards and the approved submittals:

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1. **Prework coordination:** Prior to the start of construction work on the Contract and prior to the start of work under each separate specification section and prior to the start of work where a change in a construction operation is contemplated by the Contractor and prior to a new subcontractor starting work, a coordination meeting will be held with the Contractor's Quality Control Manager, Project Manager, Superintendent, Foreman, Safety representative, Quality Control Inspector(s), MTA representative, and the DEN Project Manager, DEN Inspector(s), and DEN Quality Assurance Laboratory representative. Supervisory, Safety, and Quality Control representatives of all applicable subcontractors will also attend. The Contractor's Quality Control Manager will chair the meeting and shall distribute the proposed meeting agenda 48 hours prior to the meeting. Upon completion of the meeting, minutes including any revisions to the agenda shall be distributed within twenty-four (24) hours.
2. The purpose of the coordination meeting is to ensure that the Contractor's personnel have no misunderstandings regarding their safety and quality procedures as well as the technical requirements of the Contract. The following items shall be submitted to the DEN Project Manager no less than seventy-two (72) hours prior to the meeting and shall be presented and reviewed by the Contractor at the meeting held no less than forty-eight (48) hours prior to start of work:
  - a. Contract requirements and specifications.
  - b. Shop drawings, certifications, submittals and as-built drawings that apply.
  - c. Testing and inspection program and procedures.
  - d. Contractor's Quality Control Program.
  - e. Familiarity and proficiency of the Contractor's and subcontractor's workforce to perform the operation to required workmanship standards including certifications of installers.
  - f. Safety and environmental precautions to be observed.
  - g. Any other preparatory steps dependent upon the particular operation.
  - h. The Contractor's means and methods for performing the Work.
3. **Initial Inspection:** Upon completion of a representative sample of a given feature of the Work and no later than two (2) weeks after the start of a new or changed operation, the DEN Project Manager or the DEN Project Manager's designated representative will meet with the Contractor's Quality Control representative and applicable subcontractor's supervisor and their Quality Control representatives to check the following items, as a minimum:
  - a. Workmanship to established quality standards.
  - b. Conformance to Contract Documents and the accepted shop drawings.
  - c. Adequacy of materials and articles utilized.
  - d. Results of inspection and testing methods.
  - e. Adequacy of as-built drawings maintained daily.
  - f. Once accepted, the representative sample will become the physical baseline by which ongoing work is compared for quality and acceptability. To the maximum practical extent, approved representative samples of work elements shall remain visible until all work in the appropriate category is complete. Acceptance of a sample does not waive or alter any Contract requirements or show acceptance of any deviation from the Contract not approved in writing by the DEN Project Manager. The Contractor's Quality Control representative shall chair, prepare and distribute minutes of Quality Control meetings. Meeting minutes shall be distributed within twenty-four (24) hours of the meeting.
4. **Follow-up Inspection:** The Contractor's Quality Control representative will monitor the Work to review the continuing conformance of the Work to the workmanship standards established during the preparatory and initial inspections.
5. **Completion Inspection:** Forty-eight (48) hours prior to the completion of an item or

segment of work and prior to covering up any work, the Contractor will notify the DEN Project Manager who will verify that the segment of work is substantially complete, all inspections and tests have been completed and the results are acceptable. The purpose of this inspection is to allow further corrective work upon, or integral to, the completed segment of work. THIS IS NOT AN ACCEPTANCE INSPECTION. If any items are determined to be deficient, need correction or are non-conforming, a deficiency list will be prepared and issued to the respective Contractor for correction, repair or replacement of any deficient or non-conforming items. The DEN Project Manager and Contractor's Quality Control representative will verify the correction of the deficient and/or non-conforming items prior to the start of the next operation.

6. Pre-Final Acceptance Inspection: Prior to requesting a Pre-final Acceptance Inspection by DEN, all work and operational systems to be inspected shall be satisfactorily completed and tested by the Contractor. The Contractor's written request for this inspection shall be made seventy-two (72) hours in advance. With the request shall come a list of any known deficiencies (punch list) and the time frame in which they will be corrected. If the list is too large or contains too many significant items, in the opinion of the DEN Project Manager, no inspection will be held due to the incompleteness of the Work.
  - a. The DEN Project Manager will schedule the Pre-final Acceptance Inspection and will add to the punch list deficient items discovered during the inspection. If during the inspection the list becomes too large or too many significant items are on the list, the inspection will be canceled. After the inspection is completed, the deficiency list will be transmitted to the Contractor for correction of the deficient items.
7. Final Acceptance Inspection: After the Contractor has completed all items on the deficiency list (generated from the Pre-final Acceptance Inspection) he/she shall request a Final Acceptance Inspection. The request shall be made in writing at least seventy-two (72) hours in advance of the inspection. All areas must be cleaned and ready for turnover prior to this inspection. The DEN Project Manager, the design consultant, a representative of the funding agency, if applicable, and other interested parties will inspect the subject Work to ensure that all deficiencies have been satisfactorily attended to and that no new deficiencies have appeared and that all systems are completely functional. Any outstanding or additional deficient items will be noted and handled per the requirements of the Pre-final Acceptance Inspection noted above until the Work is acceptable to the DEN Project Manager.

### **3.04 QUALITY CONTROL TESTING PLAN.**

- A. As a part of the overall Quality Control Program, the Contractor shall implement a Quality Control Testing Plan as required by the specifications. The testing plan shall include the minimum tests and test frequencies required by each item in the Contract Documents as well as any additional quality control tests that the Contractor deems necessary to adequately control production and/or construction processes.
- B. The testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:
  1. Specification item number (e.g., P-401).
  2. Item description (e.g., Plan Mix Bituminous Pavements).
  3. Test type (e.g., gradation, grade, asphalt content).
  4. Test standard (e.g., ASTM or AASHTO test number, as applicable).
  5. Test frequency (e.g., as required by specifications or minimum frequency when requirements are not stated).

6. Responsibility (e.g., plant technician).
  7. Control requirements (e.g., target, permissible deviations).
- C. The testing plan shall contain a statistically based procedure of random sampling for acquiring test samples in accordance with ASTM D 3665. The DEN Project Manager shall be provided the opportunity to witness quality control sampling and testing.
- D. All quality control test results shall be documented by the Contractor as required by this Section.

### **3.05 DOCUMENTATION.**

- A. The Contractor shall maintain current quality control records of all inspections and tests performed. These records shall include factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, results of inspections or tests, nature of defects, deviations, causes for rejection, etc., proposed remedial action, and corrective actions taken.
- B. These records must cover both conforming and defective or deficient features and must include a statement that all supplies and materials incorporated in the Work are in full compliance with the terms of the Contract. Legible copies of these records shall be furnished to the DEN Project Manager daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the Contractor's Program Manager.
- C. Specific Contractor quality control records required for the Contract shall include, but are not necessarily limited to, the following records:
1. Certificates of compliance shall be submitted minimum thirty (30) days prior to the product's incorporation into the Work.
  2. Quality Control Charts for materials shall be established as required by the individual specification sections.
  3. Daily Foreman Report: The Foreman shall report daily construction activities using the Daily Foreman Report form QCP-1 as included in Specification Section 019990 "Standard Forms". The reports shall be completed in their entirety and shall as a minimum include the following:
    - a. Daily activities.
    - b. Quantities of material placed and completed.
    - c. Weather.
    - d. Safety issues.
    - e. Personnel.
    - f. Equipment on site with time used.
    - g. Equipment under repair.
    - h. Work delays.
    - i. Possible delays.
    - j. Materials delivered.
    - k. The reports shall be signed by the responsible foreman and Contractor Superintendent. The DEN Project Manager shall be provided a copy of each daily construction report on the work day following the day of record.
  4. Daily Quality Control Inspection Reports: Each Contractor Quality Control Inspection Technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations on forms QCP-2 and QCP-2-2 included in Section 019990 "Standard Forms". The reports shall be completed in their entirety, shall

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provide factual evidence that continuous quality control inspections have been performed and shall, as a minimum, include the following:

- a. Technical Specification item number and description.
  - b. Compliance with approved submittals.
  - c. Proper storage of materials and equipment.
  - d. Adherence to plans and specifications.
  - e. Review of quality control tests.
  - f. Compliance of quality control testing frequencies.
  - g. Identify inspections conducted, results of inspections, location and nature of defects found, causes for rejection, remedial or corrective actions taken or proposed.
  - h. The reports shall be signed by the responsible Quality Control Inspection Technician and the Program Manager. The DEN Project Manager shall be provided a copy of each report on the workday following the day of record.
5. Test Reports: The Contractor shall be responsible for establishing a system which will record all quality control test results. Daily test reports shall document the following information:
- a. Technical Specification item number and description.
  - b. Test designation.
  - c. Location.
  - d. Date of test.
  - e. Control requirements.
  - f. Test results.
  - g. Causes for rejection.
  - h. Recommended remedial actions.
  - i. Retests.
  - j. Fresh concrete properties tests and in-place moisture-density tests shall be reported in legible draft form to the DEN Inspector immediately at the test site. Any failing test shall be reported separately to a DEN Inspector or the DEN Project Manager within two (2) hours after the discovery.
  - k. Test results from each day's work period shall be transmitted to the DEN Project Manager on the next work day. These initial daily test reports shall be signed by the responsible Quality Control Technician and the Program Manager.
  - l. Typed final laboratory and field tests shall be provided to the DEN Project Manager as specified in paragraph 3.5.D "Weekly Summary Reports" below.

D. Weekly Summary Reports:

1. Typed final laboratory and field test reports summarizing the activities and results for the quality control tests and inspections for each week shall be prepared by the ITA and submitted to the DEN Project Manager. The weekly summary report shall meet the requirements of Section 014525 "Material Testing Agency" and be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all test types, test locations, testers, test results, worksheets showing all calculations used, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, the material supplier, installer, and Contractor. Retests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report. A current Correction Action Report (CAR) log shall also be included in the weekly summary report.

**3.06 CORRECTIVE ACTION REQUIREMENTS**

- A. The Quality Control Plan shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process under control. The requirements for corrective action shall include both general requirements for operation of the Quality Control Program as a whole, and for individual items of work contained in the specifications.
- B. The Quality Control Plan shall detail how the results of quality control inspections and tests will be used for determining the need for corrective action and shall contain clear sets of rules to gauge when a process is out of control and the type of correction to be taken to regain process control.
- C. When applicable or required by the specifications, the Contractor shall establish and utilize statistical quality control charts for individual quality control tests. The requirements for corrective action shall be linked to the control charts.

**3.07 SURVEILLANCE BY THE DEN PROJECT MANAGER**

- A. All items of material and equipment shall be subject to surveillance by the DEN Project Manager at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate quality control system in conformance with the requirements detailed herein and the applicable Contract Documents. In addition, all items of materials, equipment and work in place shall be subject to surveillance by the DEN Project Manager at the site for the same purpose.
- B. Surveillance by the DEN Project Manager does not relieve the Contractor of performing quality control inspections of either on-site or off-site Contractor's or subcontractor's work.

**3.08 NONCOMPLIANCE**

- A. The DEN Project Manager will notify the Contractor of any noncompliance with any of the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Any notice, when delivered by the DEN Project Manager or the DEN Project Manager's authorized representative to the Contractor or the Contractor's authorized representative at the site of the work, shall be considered sufficient notice.
- B. In cases where quality control activities do not comply with either the Contractor's Quality Control Program or the Contract provisions, or where the Contractor fails to properly operate and maintain an effective Quality Control Program, as determined by the DEN Project Manager, the DEN Project Manager may:
  - 1. Order the Contractor to replace ineffective or unqualified quality control personnel or subcontractors
  - 2. Order the Contractor to stop operations until appropriate corrective actions are taken.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

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**TECHNICAL SPECIFICATIONS**  
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**SECTION 014520 – CONTRACTOR QUALITY CONTROL**  
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- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014520**

**SECTION 014525****MATERIAL TESTING AGENCY****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Contractor shall employ the services of a Material Testing Agency; hereafter referred to as the Contractor Testing Agency (CTA). This Section identifies the requirements for the Contractor to employ a Material Testing Agency and identifies the required activities of the Material Testing Agency.
- B. Laboratory and field-testing requirements to be conducted by the CTA for materials and construction methods used on this project are included in the appropriate technical specifications. Where the Specifications reference the CDOT Standard Specifications for Road and Bridge Construction, the references shall also mean CDOT Field Materials Manual for schedule of tests unless otherwise stated. As a minimum, the CTA described in this Section shall perform all applicable tests listed in the manual including the independent assurance sampling and testing. In the event of such a conflict between the schedule and a specification in these technical provisions, the more comprehensive testing shall govern unless otherwise noted.
- C. Inspections and tests conducted by the CTA shall not in any way relieve the Contractor of the Contractor's responsibility and obligation to meet all specifications and referenced standards. Employment of the CTA does not relieve the Contractor of providing the required Quality Control program.
- D. When inspections or tests by the CTA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor as per this Section.
- E. Samples will only be considered if taken at random. The Contractor shall permit representatives of the City to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.
- F. The Contractor is obligated to correct any item deemed deficient at no additional cost to DEN.

**1.03 SUBMITTALS**

- A. All submittals shall comply with requirements of Sections 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal requirements.

**1.04 CONTRACTOR SUBMITTAL OF PROPOSED TESTING AGENCIES**

- A. The Contractor shall employ the services of a CTA that has been accredited by AASHTO or CCRL or an approved equal to perform the tests required in the Contract. The CTA may

also provide technicians to perform the required inspections. However, inspection and testing cannot be performed simultaneously by the same technician. The Contractor shall receive written acceptance from the DEN Project Manager of the CTA prior to any permanent work being installed or tested.

- B. The Contractor shall not submit for acceptance to the DEN Project Manager any testing agency or laboratory utilized in the design or construction document preparation or presently employed by DEN as part of DEN Quality Assurance, Material Testing, or special inspection agencies.
- C. For consideration of acceptance, the Contractor shall submit to the DEN Project Manager the following items received from the CTA:
  - 1. Affidavit of current accreditation from a national certification and/or accreditation program(s).
  - 2. Evidence that the CTA Laboratory is accredited to perform the testing required in the Contract Documents.
  - 3. Resumes and evidence of professional engineer registration and licensing in the State of Colorado for the personnel reviewing and signing test reports.
  - 4. Resumes and current certifications verifying that CTA management and supervisory personnel, laboratory staff, field testing technicians, and inspecting technicians are qualified in accordance with ASTM C 1077, D 3666, D 3740, and E 329 requirements to perform the Work. NICET, ACI, WAQTC, LabCAT, CDOT, NRMCA, PCA, AWS, ASNT certifications or a degree in a related engineering field with construction field experience that can demonstrate qualifications. A list summarizing all management, supervisory, laboratory, field testing, and inspection personnel assigned to the Project including the testing and/or inspection each individual will be performing, certifications held by each individual, and the expiration date of each certification.
  - 5. A matrix indicating each technical specification section, paragraph, quantity and type of sampling and/or testing required.
  - 6. Copies of all laboratory, field testing, and inspection report forms.

#### **1.05 SUBMITTAL OF REPORTS**

- A. Test results shall be submitted by the Contractor to the DEN Project Manager after completion of inspections/tests by the CTA and prior to incorporation of the items into the Work unless the test or inspection must be done during or after installation.
- B. All field test results including but not limited to fresh concrete properties and in-place moisture-density shall be reported in legible draft form to the DEN Inspector immediately at the test site. Any failing test shall be reported separately to the DEN Inspector or DEN Project Manager. The draft test results shall also be attached to the Daily Quality Control Inspection Report (reference Section 014510 "Contractor Quality Control") and transmitted to the DEN Project Manager the next workday.
- C. Typed test reports shall be provided to the DEN Project Manager as specified in the "Weekly Reports" Article in this Section. The test reports shall be numbered sequentially in chronological order. Individual tests shall be numbered sequentially. The reports and tests shall also be organized per specification section. All test results must be reviewed and signed by a registered licensed engineer in the State of Colorado. The signature represents that the test procedures used are in strict conformance with the applicable testing standard, the calculated data are true and accurate, the tools and equipment used were in calibration, the sample was not contaminated and the persons running the test were qualified.

- D. Reports of inspections and test activities are record documents and shall be maintained in a manner that provides integrity of item identification, acceptability, and traceability. Reports shall identify the following:
1. Contractor's name.
  2. DEN Contract number and title.
  3. Material Testing Agency name.
  4. Name of items inspected/tested including a physical description and, as applicable, model and make.
  5. Quantity of items.
  6. Inspection/test procedure used. If national standards are used, any deviation from these standards.
  7. Date the sample was taken and the date the test was made.
- E. Location (by coordinates, building grid or station number and elevation) of where tests and/or samplings were performed including environmental condition where applicable. Include plan drawing indicating location of test, lot size and location and work item sampled or tested.
1. Name of inspector/tester.
  2. In the event the testing or sampling is a re-test or re-sampling, reference the previous respective testing or sampling report.
  3. Specified requirements in the Contract that the item must meet. Include reference to technical specification section and paragraphs.
  4. Acceptability.
  5. Deviations/nonconformance.
  6. Evaluation of results.
  7. All information required for the specific test as specified in the applicable ASTM standard.
  8. Signature of authorized evaluator.

#### **1.06 WEEKLY SUMMARY REPORTS**

- A. The CTA and Quality Control Manager shall prepare and submit to the DEN Project Manager a weekly summary report each week, which summarizes by specification section all work activities and results for the quality control tests and inspections conducted during that period. The weekly summary report shall be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all inspections, test types, test locations, testers, test results, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, and the material supplier, installer and Contractor. Re-tests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report.
- B. The weekly report shall be submitted per Sections 013300 requirements.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

**3.01 REMOVAL OF NONCONFORMING MATERIAL**

- A. The Contractor is obligated to correct or remove nonconforming materials, whether in place or not. If necessary, the DEN Project Manager will send written notification to the Contractor to correct or remove the defective materials from the project. If the Contractor fails to respond, the DEN Project Manager may order correction, removal, and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred related to correcting, removing, and/or replacing the defective materials.

**3.02 PERFORMANCE**

- A. If the DEN Project Manager determines that the CTA or its personnel are not effectively enforcing or performing the testing and documentation requirements specified in the Contract, the DEN Project Manager will require, in writing, the Contractor to remove and replace the CTA or such personnel at no cost to DEN.

**3.03 CONTROL OF MEASURING AND TEST EQUIPMENT**

- A. The CTA shall select measuring and test equipment in such a manner as to provide proper type, range, accuracy, calibration, and tolerance for determining compliance with specified requirements. Measuring and test devices shall be calibrated, adjusted and maintained at prescribed intervals prior to use based upon equipment stability and other conditions affecting measurement. Provisions shall be made for the proper handling and storage of equipment. Calibration shall be accomplished using certified standards that have a known traceable relationship to the National Institute of Standards and Technology. Every calibrated measuring and test device shall show the current status, date of last calibration and the due date for the next calibration. Calibration records shall be maintained onsite as quality records and shall be made available for inspection upon the DEN Project Manager's request.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014525**

**SECTION 014545****SPECIAL INSPECTION AGENCY AND OWNER TESTING AGENCIES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Verify if adopted codes below are current at time of Project.
- C. Special Inspection Statement issued as part of the application for building permit for the specific task or project.

**1.02 SUMMARY**

- A. The City will employ the services of Special Inspection Agencies (SIA). This Section identifies the requirements for the Contractor to coordinate, facilitate, and support DEN and its agents and consultants to fulfill the requirements of Special Inspection.
  - 1. Any additional tests deemed necessary by the Building Official, Engineer of Record, Special Inspector or DEN Project Manager to assure these agencies that all material and work on the Project meet the requirements of the Contract and all applicable codes and regulations.
  - 2. Minimum Laboratory and field testing requirements to be conducted by the SIA for materials and construction on this Project are included in the Table at the end of this Section.
  - 3. All caissons and piers drilling on this Project shall be continuously inspected by the SIA hired by DEN directly or through the Engineer of Record or its sub-consultants.
  - 4. The Contractor shall not perform any work that could cover work or material that has not passed a special inspection or that requires the presence of the special inspector to meet the requirements of continuous or periodic inspection.
  - 5. It is the responsibility of the Contractor to plan and coordinate all testing requirements on the project to assure no delays are occurring due to the lack of inspection or testing.
  - 6. The Contractor must allow sufficient time in the schedule to perform all required inspection and testing.
  - 7. All rework due to nonconformance, failing tests or rework to test covered work prior to proper inspection and testing shall be borne by the Contractor.
  - 8. All re-inspections and re-testing costs due to non-conformances or failing tests or revisiting to test covered or incomplete work shall be borne by the Contractor at a cost of \$100 per hour in addition to all direct and indirect costs associated with testing.
  - 9. Periodic welding inspection shall include the minimum of fitting inspection and final inspection at all times.
  - 10. Inspections and tests conducted by the SIA shall not relieve in any way the Contractor of the Contractor's responsibility and obligation to meet all specifications and referenced standards. Employment of the SIA does not relieve the Contractor of providing the required Quality Control program.

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11. When inspections or tests by the SIA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor. Reference Article 5.1 of this Section.
12. Samples will only be considered if taken at random. The Contractor shall permit representatives of the City to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.
13. The Contractor is obligated to correct any item deemed deficient at no additional cost to DEN.

**1.03 SUBMITTALS**

- A. All submittals shall comply with requirements of Section 013300 "Submittals" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal requirements.

**1.04 CONTRACTOR SUBMITTAL OF PROPOSED CONTRACTOR'S TESTING AGENCIES**

- A. Projects requiring Special Inspection where the Contractor is utilizing a certified shop to produce material. DEN requires that testing be performed to satisfy the certification be no less than the following: All material and workmanship meets the requirements of a Contractor Material Testing Agency.
- B. The Contractor shall employ the services of a Testing Agency for process control and acceptance by the subcontractors and suppliers or material delivery for Contractor convenience or contractual obligations with others.
- C. The Contractor's Testing Agency must be accredited agency to perform any test required to be submitted for compliance with a Contract requirement or for use of data by DEN agencies for any official use, for examples and not to grant any obligation on the DEN Project Management Team, any payment reduction factor calculation. Any dispute or requirement to recalibrate testing equipment or machine, proof of compliance of material that was installed in contrary to manufacturer recommendation, any apparent defect due to adverse weather, improper installation, incomplete material record.
- D. Contractor's Testing Agency must be a qualified entity that has performed testing on similar jobs in size and complexity and has been accredited by AASHTO or CCRL or an approved equal to perform the tests required in the Contract. The CTA may also provide technicians to perform the required inspections. However, inspection and testing cannot be performed simultaneously by the same technician.
- E. The Contractor shall not submit for acceptance to the DEN Project Manager any testing agency or laboratory utilized in the design or construction document preparation or presently employed by DEN as part of DEN Quality Assurance.
- F. For consideration of acceptance, the Contractor shall submit to the DEN Project Manager the following items received from the CTA:
  1. Affidavit of current accreditation from a national certification and/or accreditation program.
  2. Evidence that the CTA is accredited to perform the testing required in the Contract Documents.
  3. Resumes and evidence of professional engineer registration and licensing in the State of Colorado for the personnel reviewing and signing test reports.

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4. Resumes and current certifications verifying that SIA management and supervisory personnel, laboratory staff, field testing technicians, and inspecting technicians are qualified in accordance with ASTM C 1077, D 3666, D 3740, and E 329 requirements to perform the Work. NICET, ACI, WAQTC, LabCAT, CDOT, NRMCA, PCA, AWS, ASNT certifications, or a degree in a related engineering field with construction field experience can demonstrate qualifications. A list summarizing all management, supervisory, laboratory, field testing, and inspection personnel assigned to the Project including the testing and/or inspection each individual will be performing, certifications held by each individual, and the expiration date of each certification.
5. A matrix indicating each technical specification section, paragraph, quantity and type of sampling and/or testing required.
6. Copies of all laboratory, field testing, and inspection report forms.

**1.05 SUBMITTAL OF REPORTS**

- A. Test results shall be submitted by the Special Inspector and/or DEN Testing Agency to the DEN Project Manager after completion of inspections/tests by the SIA/OTA and prior to incorporation of the items into the Work unless the test or inspection must be done during or after installation.
- B. All field test results including but not limited to fresh concrete properties and in-place moisture-density shall be reported in legible draft form to the DEN/PMT Inspection and the Contractor Quality Control Manager immediately at the test site. Any failing test shall be reported separately to the DEN/PMT Inspector or DEN Project Manager within two (2) hours after the discovery.
- C. The Contractor's Quality Control Manager or his/her Authorized representative must keep track and official record of all tests passed, failed, or defected. The Contractor shall be fully responsible to show passing tests of all required elements. The lack of any passing test record of any required element does not waive the requirement to of testing or inspection as required by the Contract Documents and the IBC. The Contractor shall bear all costs associated with recovering missing tests including but not limited to the cost of the cost of disassembling, testing or inspecting, reassembling, and any indirect time or cost impacts of a missing required test or inspection.
- D. Typed test reports shall be provided by the testing agency to the DEN Project Manager as specified in Part 1 of this Section Weekly Summary Reports. The test reports shall be numbered sequentially in chronological order. Individual tests shall be numbered sequentially. The reports and tests shall also be organized per specification section. All test results must be reviewed and signed by a registered licensed engineer in the State of Colorado. The signature represents that the test procedures used are in strict conformance with the applicable testing standard, the calculated data are true and accurate, the tools and equipment used were in calibration, the sample was not contaminated and the persons running the test were qualified.
- E. A plan of work and administrative procedure shall be established to assure that all test and inspections frequency required are performed and all defects are tracked and retested and re-inspected to meet all applicable specifications, codes, and standards.
- F. The Contractor shall track all tests performed on the daily reports and shall submit a statement for each phase of the Work showing all elements of Quality have been completed and all defects are addressed or scheduled to be addressed prior to covering the Work.
- G. Reports of inspections and test activities are record documents and shall be maintained in a manner that provides integrity of item identification, acceptability, and traceability. Reports shall identify the following:

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1. Contractor's name.
2. DEN Contract number and title.
3. Testing Agency name.
4. Name of items inspected/tested including a physical description and, as applicable, model and make.
5. Quantity of items.
6. Inspection/test procedure used. If national standards are used, any deviation from these standards.
7. Date the sample was taken and the date the test was made.
8. Location, by coordinates, building grid or station number, of where tests and/or samplings were performed including environmental condition where applicable. Include plan drawing indicating location of test and work item sampled or tested.
9. Name of inspector/tester.
10. In the event the testing or sampling is a re-test or re-sampling, reference the previous respective testing or sampling report.
11. Specified requirements in the Contract that the item must meet. Include reference to technical specification section and paragraphs.
12. Acceptability.
13. Deviations/nonconformance.
14. Corrective action.
15. Evaluation of results.
16. All information required for the specific test as specified in the applicable ASTM standard.
17. Signature of authorized evaluator.

**1.06 WEEKLY SUMMARY REPORTS**

- A. The SIA/OTA shall prepare and submit to the DEN Project Manager a weekly summary report each week that summarizes by specification section all work activities and results for the quality control tests and inspections conducted during that period.
- B. The weekly summary report shall be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all inspections, test types, test locations, testers, test results, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, and the material supplier, installer and Contractor.
- C. Re-tests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report. The SIA shall identify costs of re-testing or additional site visits required due to scheduling changes by the Contractor. A current Corrective Action Report log (CAR) shall also be included in the weekly summary report.
- D. The weekly report shall be submitted per Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" requirements.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION****3.01 CORRECTION OR REMOVAL OF NONCONFORMING MATERIAL**

- A. The Contractor is obligated to correct or remove nonconforming materials, whether in place or not. If necessary, the DEN Project Manager will send written notification to the Contractor to correct or remove the defective materials from the Project. If the Contractor fails to respond, the DEN Project Manager may order correction, removal, and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred related to the correction, removal and/or replacement of the defective materials.

**3.02 PERFORMANCE**

- A. If the DEN Project Manager determines that the SIA or its personnel are not effectively enforcing or performing the testing and documentation requirements specified in the Contract, the DEN Project Manager will, state in writing, the requirement for the Contractor to remove and replace SIA or such personnel at no cost to DEN.

**3.03 CONTROL OF MEASURING AND TEST EQUIPMENT**

- A. The SIA shall select measuring and test equipment in such a manner as to provide proper type, range, accuracy, calibration, and tolerance for determining compliance with specified requirements. Measuring and test devices shall be calibrated, adjusted and maintained at prescribed intervals prior to use based upon equipment stability and other conditions affecting measurement.
- B. Provisions shall be made for the proper handling and storage of equipment. Calibration shall be accomplished using certified standards that have a known traceable relationship to the National Institute of Standards and Technology. Every calibrated measuring and test device shall show the current status, date of last calibration and the due date for the next calibration. Calibration records shall be maintained onsite as quality records and shall be made available for inspection upon the DEN Project Manager's request.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014545**

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**SECTION 015050****MOBILIZATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Section 012910 "Schedule of Values"

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparatory work and operations including, but not limited to the following:
  - 1. Those necessary for the movement of personnel, equipment, supplies, and incidentals to the work site.
  - 2. For the establishment of all offices, buildings and other facilities necessary for the Work on the Project.
  - 3. For all other work and operations that must be performed or costs incurred prior to beginning work on the various Contract items on the work site.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Submit a Mobilization Schedule a minimum of fourteen (14) days prior to first billing for mobilization.

**1.04 DELIVERY**

- A. Delivery to the work site of construction tools, equipment, materials, and supplies shall be accomplished in conformance with all local governing regulations.

**PART 2 - PRODUCTS****2.01 PRODUCTS**

- A. Provide construction tools, equipment, materials, and supplies of the type and quantities that will facilitate the timely execution of the Work.

**PART 3 - EXECUTION****3.01 EXECUTION AND REMOVAL**

- A. Provide personnel, products, construction materials, equipment, tools, and supplies at the work site at the time they are required and scheduled to be installed or utilized.

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**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. Refer to Section 013210 – Schedule, for details regarding mobilization scheduling, billing, and payment.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. Refer to Article 1104 – Changes in the Work, Contract Price or Contract Time of the General Contract Conditions (current edition).
- B. Payment shall be made under C-105.

**END OF SECTION 015050**

**SECTION 015210  
TEMPORARY FACILITIES**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

**1.03 DESCRIPTION**

- A. The Work specified in this Section consists of furnishing, installing, operating, maintaining, and removing temporary construction barriers, enclosures, and field facilities including the Contractor's construction offices, staging areas, yards, storage areas, electrical power, telephone, water, fire protection, and sanitary service.
- B. Construction Offices, Construction Yards and Storage Areas:
1. The Contractor's offices, construction yards and laydown and storage areas shall be located as shown on the Contract Drawings and/or as designated by the DEN Project Manager. All construction offices, staging areas, and material storage areas are to occur within these areas. The DEN Project Manager may but is not required to approve the Contractor to use office, laydown areas and storage areas at DEN but not designated specifically for this Project.
  2. Any activity that is expected to result in disturbance of the ground surface equal to or greater than one acre or part of a larger project that is expected to disturb equal to or greater than one acre, is required to be identified in their Erosion Control permit. These areas include, but are not limited to, laydowns, borrow areas, stockpiles, and storage areas regardless of the location.
  3. All areas of ground disturbance are required to be stabilized in accordance with State, local, and airport rules and regulations prior to permit termination and/or closure of the Contract.
  4. The Contractor shall restore any area on DEN property that becomes contaminated as a result of its operations in accordance with Airport Rule and Regulation 180. Restoration shall be either to applicable standards under Federal and State law or to such other levels as may be required by the Manager of Aviation, at the Manager's sole discretion.
  5. All temporary facility sites must be inspected prior to Contract closeout.
    - a. The DEN Project Manager or authorized representative shall conduct an inspection of contractor areas used during the life of the project. These areas include but are not limited to, staging areas, laydown areas, borrow areas, and contractor yards and offices.

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6. The DEN Project Manager will ensure these areas have been properly stabilized in accordance with DEN Rules and Regulations and required permits. Site must be restored to the condition in which the City initially provided to the Contractor. A representative from DEN Environmental Services shall be present during the final walk through.
  7. Contractor materials shall be managed in accordance with all applicable Environmental Regulations.
  8. Temporary facilities which the Contractor desires to locate in secondary laydown and staging areas adjacent to the Work or within the project limits are subject to approval by the DEN Project Manager. If approved, these areas must also be included as part of the erosion control permit.
  9. Access to and security of the Contractor's construction offices, yard, temporary facilities, and storage areas shall be as shown on the Contract Drawings or as specified in the Contract Special Conditions.
  10. Contractor Field Office:
    - a. The Contractor shall acquire all necessary permits for installation and construction work related to the Contractor's field office and fencing.
    - b. The Contractor shall provide, as part of the Contractor's on-site field office, a conference room for weekly meetings. Minimum size to accommodate fifteen (15) people with the currently approved schedule posted on a wall. The conference room shall have a network connection with a computer monitor, and a telephone with speakerphone functionality.
    - c. Jack the mobile office unit off its wheels and provide support. Enclose the underside of the trailer with weatherproof skirting.
    - d. Install tie downs in compliance with all applicable codes.
    - e. Provide access to the field office and easily accessible space for parking six (6) full size passenger automobiles as a minimum. Grade the field office site, access roadway, and parking area for drainage, and surface with gravel paving or crushed stone.
    - f. Water and sewer lines to the field office, if installed, shall be installed so they will not freeze.
  11. All Contractor Storage Yards must be fenced. Submit fencing plan and typical details to DEN Project Manager at least seven (7) days before planned execution for review and acceptance.
  12. In accordance with Denver Fire Department Requirements, all Temporary Facilities shall have signage that lists the following information:
    - a. Company Name
    - b. Contact Telephone Number
    - c. Facility Address
- C. Electrical Service
1. Provide lighting and power for field offices, storage facilities and other construction facilities and areas.
  2. Provide power centers for electrically operated and controlled construction facilities including tools, equipment, testing equipment, interior construction lighting, heating, cooling and ventilation equipment.
  3. Provide night security lighting at secured areas within construction limits at offices, storage facilities, temporary facilities and excavated areas.
  4. Provide battery operated or equivalent emergency lighting facilities at construction areas where normal light failures would cause employees to be subjected to

hazardous conditions. Test such facilities monthly and maintain a record of these tests for the DEN Project Manager's review.

5. Contractor shall bear all costs of temporary electric service permits, fees, and deposits required by the governing authorities, and connection charges and temporary easements including installation, maintenance, and removal of equipment.
- D. Telephone/Communications Service:
1. The contractor shall furnish, install, and maintain broadband telecommunications service in the contractor's main field office. Contractor shall also furnish, install, and maintain telephony service at the main field office, or cellphone(s) such that the DEN Project Manager is able to reach a contractor's representative at all times.
  2. Comply with requirements of Division 26 Sections.
- E. Water Service:
1. The Contractor shall make all connections and extensions required and shall make use of water in direct support of the Work. The Contractor shall install an approved Water Department tap at the City's water source prior to obtaining any water. The Contractor shall arrange and pay for its supply/distribution system from the City's point of connection. The location and alignment of the Contractor's temporary supply/distribution system must be approved by the DEN Project Manager prior to its installation. The Contractor shall leave in place all above ground and underground water distribution facilities unless otherwise directed by the DEN Project Manager.
  2. The Contractor shall not use in place fire hydrants or standpipes as sources for construction water or potable water.
  3. Comply with requirements of Division 22 Sections.
- F. Fire Protection:
1. Furnish, install, and maintain temporary portable fire protection equipment throughout the construction period at all buildings (including the project site), maintenance shops, and fuel storage on all large construction equipment and at the location of any flammable materials or construction materials.
  2. Comply with requirements of Division 21 Sections.
- G. Sanitary Service:
1. Furnish, install, and maintain temporary sanitary facilities and services throughout the construction period.
  2. Ensure that separate or single user toilets shall be provided to ensure privacy between the sexes.
  3. Provide general washing facilities adequate for the number of employees.
  4. Provide special washing facilities adequate for the number of employees engaged in the application of paints, coating, and other volatile or hazardous materials.

#### **1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Submit a shop drawing within five (5) days of the Notice to Proceed that shows the following:
  1. Temporary facilities equipment and materials (include manufacturer's literature).

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2. Details and layout of temporary installations including fences, roads, parking, buildings, storage areas, signage, and drainage plans.
3. Lighting plan showing temporary lighting facilities, electrical service panel location, electrical circuit diagram, and anticipated light level on the working roadway, pathway, or construction surface.
4. As-built description of any temporary underground utilities referenced to the Airport grid and benchmark system within five (5) days of completion of the installation.
5. Copies of all permits for all temporary facilities.

**1.05 QUALITY CONTROL**

- A. Provide products for, and the execution of, the Work of this Section that will satisfy the requirements of all applicable codes. Provide products that satisfy the requirements of the applicable codes.

**PART 2 - PRODUCTS****2.01 ELECTRICAL SERVICE**

- A. Provide temporary power and lighting equipment consisting of fixtures, transformers, panel boards, groundings, lamps, switches, poles, conduits and wiring sized and capable of continuous service and having adequate capacity to ensure a complete operating system. Comply with NEMA and Division 26 requirements.

**2.02 TELEPHONE/COMMUNICATIONS SERVICE**

- A. Provide equipment that is compatible with that of the current DEN service provider and the telephone exchange to which the Contractor connects.

**2.03 POTABLE WATER SERVICE**

- A. Provide sanitary materials and equipment that satisfies the requirements of codes and regulations pertaining to temporary water systems. Bottled products may be used if those products comply with codes. Clearly label portable containers having a dispensing tap and used only for drinking water. Provide single service disposable cups and a sanitary container for dispensing cups. A trash receptacle shall be provided and maintained beside each portable water supply.
- B. If paints, coatings and other volatile or hazardous materials injurious to humans will be applied as part of the Contract, provide washing facilities with warm water of approximately 120 degrees F.

**2.04 FIRE PROTECTION**

- A. Fire extinguishers shall be UL rated and shall comply with the International Fire Code with City of Denver amendments.

**2.05 SANITARY SERVICE**

- A. Provide materials and equipment adequate for the intended purposes, which will neither create unsanitary conditions nor violate the codes applicable to temporary sanitary facilities. Enclosures for toilet and washing facilities shall be weatherproof, sight proof, ventilated and sturdy, and shall be maintained in clean conditions.

- B. Provide portable type toilet facilities that satisfy the requirements of OSHA.
- C. Provide washing facilities as needed. Furnish soap, single-service paper towels, towel dispenser, and towel receptacle.

### **PART 3 - EXECUTION**

#### **3.01 ELECTRICAL SERVICE**

- A. The approximate location of primary power lines is shown on the Construction Drawings. The Contractor shall locate electrical service where it will not interfere with equipment, storage spaces, traffic, and prosecution of the Work or the work of others. Installation shall present a neat and orderly appearance and shall be structurally sound. Maintain service in a manner that will ensure continuous electrical service and safe working conditions.
- B. Comply with requirements of Division 26 Sections.

#### **3.02 TELEPHONE/COMMUNICATION SERVICE**

- A. Install temporary telephone service in a neat and orderly manner, and make structurally and electrically sound to ensure continuous service. Modify, relocate, and extend, as work progress requires. Place conduit and cable where those products will not interfere with traffic, work areas, materials, handling equipment, storage areas, and the work of other contractors. Service lines may be aerial.

#### **3.03 WATER SERVICE**

- A. Install the systems in a neat and orderly manner. Make them structurally and mechanically sound. Provide continuous service. Modify, relocate, and extend the systems as the Work progresses.
- B. Comply with requirements of Division 22 Sections.
- C. Locate systems where they will be convenient to work stations, sanitary facilities, and first aid station but will not interfere with traffic, work areas, materials handling equipment, storage areas, or the work of other contractors.
- D. Provide sanitary bubbler drinking fountains if potable water service is available. Disinfect water piping before using for the potable water service.
- E. Install vacuum breakers, backflow preventers, and similar devices in a manner and location that will prevent temporary water from returning to the water mains.
- F. Do not incorporate any part of temporary water distribution system into the permanent water distribution system.

#### **3.04 FIRE PROTECTION**

- A. Install products in conformance with the requirements of the applicable Denver Fire Department and OSHA regulations.
  - 1. Provide functional, approved fire extinguishers that are clearly identified for fire and an accessible supply of water during the period of construction. These fire extinguishers shall remain in place until permanent fire protection systems are functional.
- B. Instruct construction personnel as to location and use of temporary fire protection

equipment.

- C. Comply with requirements of Division 21 Sections.

### **3.05 SANITARY SERVICE**

- A. Place temporary sanitary and washing facilities in a neat and orderly manner within the limits of the Work and convenient to the workstations. Make these facilities structurally and mechanically sound. Modify, relocate, and extend the facilities as required by progress of the Work.
- B. Service toilets at those time intervals that will minimize the accumulation of wastes and prevent creation of unsanitary conditions, but not less than once a week.
- C. The waste from the sanitary and wash facilities shall be disposed of in accordance with all applicable rules, regulations, and laws and with the least environmental impact.

### **3.06 FENCING**

- A. Contact all utility service companies prior to planning fence location and post locations for certification of current utilities. Locate pothole posts planned within five (5) feet of known utilities.

### **3.07 SIGNAGE**

- A. Contractor shall not provide any signage for temporary facilities without prior approval from the DEN Project Manager.

### **3.08 REMOVAL**

- A. The Contractor shall locate all temporary facilities including the underground utilities so they can be completely removed without damaging permanent work or the work site of other contractors.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 015210**

**SECTION 015215**

**FIELD OFFICES**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of furnishing, installing and maintaining a field office at the work site for the City's use.
- B. DEN Shall provide field offices at the location specified by the Contract Documents.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 015215**

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**SECTION 15525**  
**TRAFFIC CONTROL**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of furnishing plans and designs for traffic control and haul routes, implementing these plans with all necessary personnel and equipment. Installation may require but not be limited to signage, cones, flaggers, signal lights, lighting and temporary roads.
- B. All Work must be in conformance with the "Manual of Uniform Traffic Control Devices for Streets and Highways" (MUTCD) and CDOT Standard Plans regarding traffic control.
- C. The Contractor must coordinate the Contractor's proposed traffic control needs with the needs of other contractors on the airport construction site in writing through the DEN Project Manager.
- D. Refer to Article 805 – Protection of Street and Road System in the General Contract Conditions, Current Edition.

**1.03 QUALITY CONTROL**

- A. Temporary signal work shall conform to CDOT Standard Plans and the current version of the CDOT Standard Specifications.
- B. Designate a qualified person to inspect and test traffic control devices daily and to ascertain that those devices are continuously operating, serviceable, in place, and clean.
- C. Provide certified personnel who will be responsible for design, implementation, and inspection of traffic control needs.

**1.04 SUBMITTALS**

- A. Refer to Technical Specifications Sections 013300 "Submittals" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Submit a Traffic Control Plan (TCP) that includes, at a minimum, the following list of items for approval before starting Work. Submit an updated TCP when necessary to modify traffic operation or undertake a construction activity that creates a different traffic pattern:
1. Traffic blockade and reductions anticipated to be caused by construction operations.
  2. Temporary detours.
  3. A Method of Handling Traffic (MHT) must be submitted and approved by the DEN Project Manager, which at a minimum will show and describe proposed location, dates, hours, and duration of detours, vehicular traffic routing, and management, traffic control devices for implementing detours and details of barricades.

- C. Submit Haul Route Plan for both on- and off-site hauls. The Haul Route Plan shall be submitted 30 days prior to hauling any permanent material. The Plan shall be updated as the Contractor's plans change.
- D. Specific Traffic Considerations: The DEN Project Manager may require the Contractor to revise the Traffic Control Plan to address traffic considerations not included in the Contractor's plan.
- E. Shutdown requests for any impact to traffic must be submitted for approval a minimum of five days before the intended shutdown. These requests will be made through the DEN Project Manager.

## **PART 2 - PRODUCTS**

### **2.01 TRAFFIC CONTROL DEVICES**

- A. Devices including signs, delineators, striping, barriers, barricades, and high-level warning devices shall conform to the latest revision of the MUTCD and the latest revision of the Colorado Department of Transportation Standard Plans.

## **PART 3 - EXECUTION**

### **3.01 TEMPORARY TRAFFIC CONTROL DEVICES**

- A. Place temporary control devices in a manner that allows for the smooth flow of traffic at the posted speed limit, limiting hazards or abrupt changes in direction.
- B. Place traffic cones or delineators as directed by the MUTCD. Operate warning lights between sunset and sunrise.
- C. Place control devices so that approaching traffic is alerted to hazards and variances to normal traffic patterns.
- D. Clean and repair damaged devices or replace them with new devices as required.

### **3.02 TEMPORARY TRAFFIC STRIPING AND PAVEMENT MARKINGS**

- A. Full-compliance striping is required at all times per the MUTCD.
- B. Temporary signs must be replaced with permanent signing within three days per the MUTCD.

### **3.03 FLAGGERS**

- A. Furnish flaggers where required for safety and by the MHT.

### **3.04 CONSTRUCTION VEHICULAR TRAFFIC**

- A. Restrict construction vehicles to approved haul routes.
- B. Haul routes on the airfield must be approved by Security.

### **3.05 CONTROLLING VEHICULAR AND PEDESTRIAN FLOW ADJACENT TO WORK SITE**

- A. Ensure that construction operations will not impede normal traffic. Where work is in the area

of pedestrian or occupant activity, the Contractor shall detail a plan for managing pedestrian traffic safely. Refer to Title 8 - Protection of Persons and Property, Section 801.1 in the General Contract Conditions, Current Edition.

### **3.06 SIGNS**

- A. Refer to Title 8, Article 802 - Protective Devices and Safety Precautions in the General Contract Conditions, Current Edition.
  - 1. The Contractor must contact the DEN Project Manager a minimum of five (5) working days in advance of construction for installation, relocation, or removal of regulatory parking signs.
- B. Coordinate and pay any expense associated with the furnishing and installation of all parking regulatory signs, such as "No Stopping Any Time," etc., at the work site.
- C. Furnish and install any necessary advance detour or guidance signing.
- D. Authorize, modify, and install regulatory parking controls and vehicle turn restrictions.
- E. Implement those traffic control modifications outside of the traffic control zone that are necessary to manage diverted traffic.
- F. Clean and repair damaged signage or replace with new signage within 24 hours, and provide mitigation as required to maintain site safety until signage has been installed.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. Measurement for Traffic Control shall be per lump sum. This item shall include installation, maintenance, re-positioning (as required by phase or the DEN Project Manager) and removal upon completion; of the low profile barricades (with lights), tubular barricades, temporary haul routes and temporary signage, temporary pavement markings, gates, and any other item associated with providing traffic control for the project including, but not necessarily limited to, the preparation and submittal of traffic control plans.
- B. Measurement for Flagger shall be made per hour. This shall include all associated costs with providing the flaggers. The quantity to be measured for flagging will be the total number of actual flagging hours that are used in place and actively flagging. Payment will not be made for time spent by flaggers to set up and take down construction traffic control devices or for 'break flaggers' not actively flagging and shall instead be incidental to Traffic Control work item.
- C. Measurement for Gate Guard shall be made per hour. This shall include all associated costs with providing the Gate Guards.
- D. Measurement for Gate Guard Shack shall include the installation, maintenance, and removal of the guard shack at Gate(s) shown on the Contract Drawings including all required incidental items described in the Contract Drawings.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT.**

- A. Item 015525-1 Traffic Control Payment will be made at the contract unit price per lump sum. This price shall include installation, maintenance, re-positioning (as required by phase or the DEN Project Manager) and removal upon completion; of the low profile barricades (with lights), tubular barricades, temporary haul routes and temporary signage, temporary pavement markings, gates, and any other item associated with providing traffic control for the project.
- B. Item 015525-2 Flagger Payment per hour.
- C. Item 015525-3 Gate Guard Payment per hour.
- D. Item 015525-4 Gate Guard Shack Payment will be made at the contract unit price per lump sum. This price shall include the installation, maintenance, and removal of the guard shack at Gate G7 including all required incidental items described in the Contract Drawings.

**END OF SECTION 015525**

**SECTION 015719****TEMPORARY ENVIRONMENTAL CONTROLS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Specifications Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Title 8 - Protection of Persons and Property in the General Contract Conditions, 2011 Edition, specifically the following articles:
  - 1. Article 806 - Protection of Drainage Ways
  - 2. Article 807 - Protection of Environment
  - 3. Article 808 - Hazardous and Explosive Materials or Substances
  - 4. Article 809 - Archaeological and Historical Discoveries
- C. Denver Municipal Airport System Rules and Regulations, Part 180-Environmental Management.
- D. DEN Environmental Management System (EMS)

**1.02 SUMMARY**

- A. The Work specified in this Section consists of identifying, and avoiding or mitigating adverse environmental impacts to air, water, soil, and other natural resources caused by construction activities.
  - 1. The Contractor, in conducting any activity on airport property or in conducting work for an airport project not on airport property, shall comply with all applicable airport, local, state, and federal rules, regulations, statutes, laws, and orders.
  - 2. Work shall not commence on any project until all FAA approvals have been received, applicable permits have been issued and signed by permittee, and all inspection requirements have been satisfied in accordance with State and local permitting requirements.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Within ten (10) days after Notice to Proceed on a task order, the Contractor shall submit the following if applicable, unless waived by the DEN Project Manager:
  - 1. Submittals pertaining to water quality management:
    - a. Construction Activities Stormwater Discharge Permit
      - 1) City and County of Denver
        - a) Sewer Use & Drainage Permit (SUDP)
        - b) Construction Activities Stormwater Discharge Permit (CASDP)
      - 2) Colorado Department of Public Health and Environment (CDPHE) Colorado Discharge Permit System (CDPS) Authorization to Discharge (Contractor need not submit a copy of the general permit or the general permit rationale)

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- a) CDPS General Permit for Stormwater Discharges Associated with Construction Activities
- b) CDPS General Permit for Associated with Non-Extractive Industrial Activity
- c) CDPS General Permit for Construction Dewatering Discharges (Prior to obtaining a CDPS General Permit for Construction Dewatering Discharges permit, the Contractor shall submit a draft permit application and the final permit application for DEN review and approval PRIOR to submittal to CDPHE. The Contractor need not submit a copy of the general permit or the general permit rationale.
- 3) Upon request the contractor shall provide the following documentation
  - a) Stormwater Management Plan (SWMP)
  - b) CASDP Inactivation Request
  - c) CDPS Notice of Termination
  - d) Permit Transfer Application
  - e) Modification Application
  - f) Discharge Monitoring Reports (DMRs)
  - g) A copy of the well permit from the state Division of Water Resources for every new well that diverts or for the monitoring of groundwater. (A draft copy of the Notice of Intent for any borehole structure filed with the state Division of Water Resources).
  - h) Section 404 related permitting (Prior to obtaining a permit issued by the US Army Corps of Engineers, the contractor shall submit a draft copy of the application and coordinate with efforts DEN Environmental Services).
- 4) Revisions or amendments to the CASMP by the Contractor: At the completion of the Project, after final stabilization has been achieved and accepted in accordance with CASDP requirements, the Contractor shall submit a copy of the CASDP Inactivation Request.
2. Submittals pertaining to sewage holding tanks associated with buildings and trailers: For purposes of this Section, the generic term “sewage holding tank” means “onsite wastewater treatment system (OWTS),” “individual sewage disposal system (ISDS),” “privy vault,” “septic tank,” or “septic system”:
  - a. Draft copy of the permit application for a sewage holding tank.
  - b. Copy of the Sewer Use & Drainage Permit issued by the Denver Department of Public Works.
  - c. Copy of the OWTS permit issued by the Denver Department of Environmental Health.
3. Submittals pertaining to air quality management:
  - a. Copy of any permit issued by the CDPHE Air Pollution Control Division (APCD)
4. Submittals pertaining to storage tanks and containers:
  - a. Copy of the approved application issued by the State of Colorado, Department of Labor and Employment, Division of Oil and Public Safety, for installation of petroleum, or other regulated substances, storage tanks located on airport property and used for the Project.
  - b. Copy of permits issued by the Denver Fire Department for storage tank installations, storage tank removals, and hazardous materials use/storage.
  - c. Copy of Spill Prevention, Control, and Countermeasure (SPCC) Plan for petroleum storage tanks and containers with capacity of 55 gallons of oil or greater located on airport property and used for the Project.
5. Copies of any other plans, permits, permit applications, correspondence with regulatory agencies, including violations, waste manifests, results of laboratory analyses, or other environmental documentation required for the Project not

previously identified herein.

#### **1.04 RELATED DOCUMENTS**

- A. Code of Federal Regulations (CFR) Publications, including, but not limited to, the following:
  - 1. 33 CFR 323 - Permits for discharges of dredged or fill materials into waters of the United States.
  - 2. 40 CFR - Protection of Environment.
  - 3. 49 CFR 171-180 Hazardous Materials Transportation Regulations.
- B. Colorado Revised Statutes, including, but not limited to, the following:
  - 1. Water Quality Control, Title 25, Article 8.
  - 2. Air Quality Control, Title 25, Article 7.
  - 3. Hazardous Waste, Title 25, Article 15.
  - 4. Noise Abatement, Title 25, Article 12.
  - 5. Petroleum Storage Tanks, Title 8, Article 20.5.
  - 6. Liquefied Petroleum Gas (LPG) Storage Tanks, Title 8, Article 20, Part 4.
  - 7. Solid waste regulations.
- C. City and County of Denver Executive Orders, including, but not limited to, the following:
  - 1. Executive Order No. 115 - Required Use of Denver-Arapahoe Disposal Site (Landfill).
  - 2. Executive Order No. 123 - Office of Sustainability and Citywide Sustainability Policy.
  - 3. Denver Revised Municipal Code, Title II, Sections 48-44 and 48-93 - Solid Waste.
  - 4. Denver Revised Municipal Code, Title II, Section 4-43 – Idling Restriction.
- D. City and County of Denver Construction Activities Stormwater Manual.
- E. Any other applicable rules, regulations, ordinances, and guidance must be followed as applicable.
- F. Refer to Section 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- G. Refer to Section 017419 "Construction Waste Management" for waste management requirements

### **PART 2 - PRODUCTS**

#### **2.01 PRODUCTS**

- A. Products required for the Work shall meet all Environmental Requirements.
- B. At a minimum, products for erosion and sediment control must conform to the technical requirements contained in the City and County of Denver "Construction Activities Stormwater Manual" and the current version of the "Mile High Flood District's Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices".

### **PART 3 - EXECUTION**

**3.01 AIR POLLUTION CONTROLS**

- A. The Contractor shall use appropriate control measures to comply with applicable air quality permit requirements. Additionally, the Contractor must be aware of the following procedures and techniques while conducting construction activities on DEN property. NOTE: Application of dust control measures should be discussed and outlined in the Dust Control Plan.
1. Apply water as needed to the construction site haul roads, disturbed surface areas and public access roads as needed to suppress dust. The use of chemical stabilizer can be requested by the Contractor. The type of stabilizer to be used and locations of use must be included in the Dust Control Plan, which must be approved by the DEN Project Manager prior to application.
  2. The Contractor shall suspend all earthmoving activities if wind speed exceeds 30 mph. For purposes of this Section, the generic term "earthmoving" means clearing, grubbing, excavation, topsoil removal, backfilling, embankment work, grading, trenching, drilling, and installation of borings. Contractors are expected to check wind speeds with the airport's ramp tower to demonstrate compliance with this requirement. In addition, the Project may be shut down if two of three of the Runway Visual Range (RVR) instruments read visibility of 2,400 feet or less. The instruments are used by FAA Control Tower personnel to ensure safe aircraft operations. Costs for shutdowns due to wind velocities or RVR readings shall not be grounds for delay or extra cost claims.
- B. Burning of materials is strictly prohibited on DEN property.

**3.02 WATER POLLUTION CONTROLS**

- A. The Contractor shall conduct construction activities in accordance with all applicable permit requirements. In addition, the Contractor shall comply with the following procedures and requirements while conducting activities on DEN property:
1. Water encountered during construction cannot be discharged to the stormwater system or placed onto the ground surface without a permit AND prior written approval by the DEN Project Manager. If groundwater or stormwater is anticipated to be encountered and the Contractor desires to discharge it to the stormwater system or onto the ground surface, then the Contractor must obtain an appropriate CDPS discharge permit in advance of the discharge unless this activity is specifically authorized under the CDPS Construction Stormwater Permit.
  2. If water is encountered and the Contractor desires to discharge these waters to the sanitary sewer system, then the Contractor must obtain approval from DEN Environmental Services in advance of the discharge.
  3. The Contractor shall ensure that stormwater that comes in contact with storage areas does not become impacted and discharged to the stormwater sewer system or to an impervious surface. Furthermore, any materials in storage areas shall not be stored directly on the ground.
  4. The Contractor shall not operate any valves, sluice gates or other drainage appurtenances related to any DEN sewer system without the prior approval of both the DEN Project Manager and DEN Environmental Services. Any violation of this directive may result in the payment of a financial penalty by the Contractor if the State of Colorado assesses such a penalty.

**3.03 EROSION CONTROL AND SEDIMENTATION CONTROL**

- A. This Work consists of constructing, installing, maintaining and removing, if required, temporary and permanent control measures during the life of the Contract (and possibly

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afterward) until the Contractor achieves final stabilization of the site to prevent or minimize erosion, sedimentation, and pollution of any state waters in accordance with all Environmental Requirements.

- B. The Contractor is responsible for compliance with all requirements in accordance with the CASDP, the City and County of Denver Construction Activities Stormwater Manual, the approved CASMP, and CDPS-issued permits.
- C. Temporary facilities, including but not limited to storage areas, laydowns, borrow areas, and contractor offices and work yards, shall be managed in accordance with Section 015210 "Temporary Facilities".
- D. Clean soil fill may be stockpiled in any area that has been previously approved and signed off by the DEN Section Manager of Construction, Design and Planning, and Environmental Services. Soil stockpiles are considered a potential pollutant source and must be addressed in the CASMP and/or SWMP.
- E. Make immediately available, upon the DEN Project Managers request, all labor, material, and equipment judged appropriate by the DEN Project Manager to maintain suitable erosion and sediment control features. These actions requested by the DEN Project Manager take precedence over all other aspects of project construction that have need of the same labor, material and equipment, except those aspects required to prevent loss of life or severe property damage.

**3.04 CONSTRUCTION OF CONTROL MEASURES FOR EROSION AND SEDIMENTATION**

- A. The Contractor must install control measures in accordance with the most recent version of the "Mile High Flood District's Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices and the City and County of Denver Construction Activities Stormwater Manual".
  - 1. Deviations from these two documents are allowed with written consent from the City and County of Denver CASDP Inspector.

**3.05 STORAGE OF OIL, FUELS, OR HAZARDOUS SUBSTANCES**

- A. The Contractor shall prevent oil or other hazardous substances, as defined in federal and state regulations, from entering the ground, drainage or local bodies of water, and shall provide containment, diversionary structures, or equipment to prevent discharged oil from reaching a watercourse and take immediate action to contain and clean up any spill of oily substances, petroleum products, or hazardous substances. The Contractor shall provide one or more of the following preventive systems at each petroleum storage site:
  - 1. Dikes, berms, or retaining walls capable of containing at least 100% of the volume of the largest single tank and equipped with sufficient freeboard to contain precipitation events. The secondary containment must be "sufficiently impermeable" to prevent a release to the environment.
  - 2. Culverting, curbing, guttering, or other similar structures capable of containing at least 100% of the volume of the largest single tank and freeboarding from precipitation.
- B. The provision of such preventive systems shall be subject to acceptance by the DEN Project Manager prior to tank installation and shall follow the SPCC regulations (40 CFR Part 112).
- C. Prior to bringing any containers of 55-gallon or above capacity onto DEN property for storage of oil, fuel, or other petroleum substances, the Contractor may be required to prepare an SPCC Plan that conforms to 40 CFR Part 112. The plan must include a

certification either from a Professional Engineer or self-certification, if applicable, as well as management approval from the legally responsible Contractor representative.

### **3.06 SPILL RESPONSE AND NOTIFICATION**

- A. The Contractor is responsible for all spills that may result from its activities. For ANY suspected or confirmed release or spill of oil, fuel, solid waste, hazardous waste, unknown materials, lavatory waste, or miscellaneous chemicals, etc., that occurs as the result of the Contractor's activities on DEN property, the Contractor is required to take immediate action to mitigate the release or spill and report it to the DEN Project Manager and to the DEN Communications Center at (303) 342-4200.
- B. The Contractor is responsible for notifying the appropriate regulatory agency in the event suspected and/or confirmed releases are identified, in accordance with regulatory requirements.

### **3.07 SITE REMEDIATION AND RESTORATION**

- A. The Contractor shall be required to perform any necessary site assessment and remediation activities required by applicable regulatory agency.
- B. During routine construction activities, the Contractor is required to manage soils using typical construction techniques. The Contractor must differentiate between soils and wastes, including contaminated soils versus clean soils, and determine those materials that can remain on DEN property and those that must be transported off site for disposal.
- C. During all construction activities that require the management of soils, the Contractor must notify the DEN Project Manager and DEN Environmental Services (ES) that soils being managed may be impacted by industrial activities conducted at the airport. "Process knowledge" pertaining to previous use and/or impact for the locations under construction can be used to determine whether impacted soils are probable. Also, common indices such as soil staining and odor can be used as a determination for the probable condition. If probable contamination conditions are suspected, the Contractor will notify the DEN Project Manager and DEN ES immediately. At that time, which may be before the Work is initiated where indicative conditions exist, all work will cease until a sampling and analysis approach is determined and implemented by the proper responder.
- D. If the site conditions warrant based on evidence of spillage or contamination, process knowledge, and/or visual or olfactory observations, the Contractor may be required to conduct sampling and analysis to confirm that no remedial action is required. Prior to conducting any removal activities, the Contractor must provide a Scope of Work to the DEN Project Manager describing the proposed site assessment activities.
- E. The impacted project will modify its operation to include a segregation area where probable impacted soils can be placed, stored, and sampled for characterization. Should the soil materials be determined to exceed the applicable standards, the DEN Project Manager, in conjunction with DEN ES, will be responsible for the proper disposal of these materials. Materials that are determined to contain contamination levels below the applicable standards can be considered clean soils and placed back into the excavation or reused elsewhere on DEN property. In accordance with Part 3 of this Section, materials removed that are suitable for recycling will be placed within areas designated on DEN to store these materials.
- F. The Contractor shall restore any area on the Airport that becomes contaminated as a result of its operations. Restoration shall be either to applicable standards under federal and state law or to such other levels as may be required by the Manager of Aviation, at the Manager's

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 015719 – TEMPORARY ENVIRONMENTAL**  
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sole discretion. Such restoration shall be completed at the earliest possible time, and the Contractor's restoration shall be subject to inspection and approval by the Manager of Aviation or duly authorized representative. See DEN Rules & Regulations - Part 180.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. Temporary erosion and pollution control work (including dust control) required will be performed as scheduled or directed by the RPR, including erosion control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites. Temporary erosion and pollution control work will be paid as a lump sum. The Contractor shall submit unit prices, anticipated quantities, and costs of necessary permits for temporary erosion and pollution control items to the DEN PM.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. Temporary erosion and pollution control work will be paid for under:

Item 015719-1 Erosion Control Measures (Temporary) - per lump sum

**END OF SECTION 015719**

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**SECTION 015810**  
**TEMPORARY SIGNS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes requirements for the following:
1. Construction signage visible to the public.
  2. Temporary directional, informational, or regulatory signage.
- B. Related Requirements:
1. Section 015210 "Temporary Facilities" for requirements for temporary facilities.

**1.03 SUBMITTALS**

- A. Submit temporary sign finishes, materials and paint, etc., for review and approval by DEN Project Manager prior to any fabrication.

**1.04 QUALITY CONTROL**

- A. Construction and other temporary signage visible to the public must be commercial grade quality, professionally fabricated, and installed based on the location of the sign. The Contractor is responsible to maintain this signage until it is no longer needed, and to remove signage from the site.

**PART 2 - PRODUCTS****2.01 GENERAL**

- A. Interior signs that are visible and not physically accessible to the public may be made of rigid board, such as "Gator Board", with vinyl messages. All edges must be finished and all fasteners concealed.
- B. Interior signs that are visible and physically accessible by the public must be vandal-proof. Acceptable examples of vandal-proof signs are messages applied second surface with concealed tamperproof fasteners.
- C. Exterior signs must be vandal-proof and fabricated of weatherproof materials.

**PART 3 - EXECUTION****3.01 HARDWARE**

- A. Interior Signs: Attach with suitable adhesive and/or tape which may be removed without damage to finishes.

- B. Exterior Signs: Must be secured to withstand site conditions and varying weather conditions.

**3.02 SIGN FINISHES, MATERIALS, AND PAINT**

- A. Provide temporary signage to reflect permanent sign design and/or as directed by the DEN Signage Design Project Manager. Submit temporary sign finishes, materials and paint, etc., for review and approval prior to any fabrication.

**3.03 MAINTENANCE**

- A. The Contractor shall maintain temporary signage until it is no longer needed, as determined by DEN Project Manager.

**3.04 REMOVAL**

- A. The Contractor shall remove all temporary signs, and clean and refurbish affected areas to their original, or intended, condition.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 015810**

**SECTION 016000**  
**PRODUCT REQUIREMENTS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
1. Section 012300 "Alternates" for products selected under an alternate.
  2. Section 012510 "Substitutions" for requests for substitutions.
  3. Section 014225 "Reference Standards" for applicable industry standards for products specified.

**1.03 DEFINITIONS**

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

**1.04 SUBMITTALS**

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number, title, and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. DEN Project Manager's Action: If necessary, DEN Project Manager will request additional information or documentation for evaluation within one week of receipt of a comparable product request. DEN Project Manager will notify Contractor[ through Construction Manager] of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.
  - a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
  - b. Use product specified if DEN Project Manager does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

### **1.05 QUALITY ASSURANCE**

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
  1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  2. If a dispute arises between contractors over concurrently selectable but incompatible products, DEN Project Manager will determine which products shall be used.

### **1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
  1. Store products to allow for inspection and measurement of quantity or counting of units.
  2. Store materials in a manner that will not endanger the Project, including the structure.
  3. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

### **1.07 PRODUCT WARRANTIES**

- A. Refer to Title 18 - Warranties, Guarantees and Corrective Work of the General Contract Conditions, 2011 Edition.
- B. Submittal Time: Comply with requirements in Section 017720 "Contract Closeout."

## **PART 2 - PRODUCTS**

### **2.01 PRODUCT SELECTION PROCEDURES**

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged, and unless otherwise indicated, are new at time of installation.
  1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," DEN Project Manager will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
  1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  3. Products:
    - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
    - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in

"Comparable Products" Article for consideration of an unnamed product.

4. **Manufacturers:**
    - a. **Restricted List:** Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience [will] [will not] be considered[ unless otherwise indicated].
    - b. **Nonrestricted List:** Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
  5. **Basis-of-Design Product:** Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. **Visual Matching Specification:** Where Specifications require "match DEN Project Manager's sample", provide a product that complies with requirements and matches DEN Project Manager's sample. DEN Project Manager's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012510 "Substitutions" for proposal of product.
- D. **Visual Selection Specification:** Where Specifications include the phrase "as selected by DEN Project Manager from manufacturer's full range" or similar phrase, select a product that complies with requirements. DEN Project Manager will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## **2.02 COMPARABLE PRODUCTS**

- A. **Conditions for Consideration:** DEN Project Manager will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, DEN Project Manager may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## **2.03 MATERIALS**

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**TECHNICAL SPECIFICATIONS  
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- A. General: Comply with requirements specified in other Sections.
  
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to DEN Project Manager for the visual and functional performance of in-place materials.

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 016000**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 016610****STORAGE AND PROTECTION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of providing storage and protection of the materials, products and supplies which are to be incorporated into the construction and indicating such storage areas on the working drawings with the location and dates when such areas will be available for each purpose.
- B. Related Requirements:
- C. Section 015210 "Temporary Facilities" for requirements for temporary facilities.

**1.03 SUBMITTALS**

- A. Refer to Technical Specifications Sections 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures. Submit concurrently with submittals required in Section 013223 "Construction Layout, As-built and Quantity Surveys".
- B. Submit working drawings showing locations of storage areas not indicated on the Contract Drawings.
- C. Submit descriptions of proposed methods and locations for storing and protecting products.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Materials required for the storage and protection of the items specified shall be durable, weatherproof and either factory finished or painted to present an appearance acceptable to the DEN Project Manager and the City. Storage facilities shall be uniform in appearance with similar materials used to the maximum extent possible.

**PART 3 - EXECUTION****3.01 GENERAL REQUIREMENTS OF EXECUTION**

- A. Palletize materials, products, and supplies that are to be incorporated into the construction immediately so they are stored off the ground. Material and equipment shall be stored only in those areas that are indicated as storage areas on the Contract Drawings and on the reviewed and accepted working drawings.
  - 1. Store these items in a manner which will prevent damage and facilitate inspection.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 016610 – STORAGE AND PROTECTION**

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2. Leave seals, tags, and labels intact and legible.
  3. Maintain access to products to allow inspection.
  4. Protect products that would be affected by adverse environmental conditions.
- B. Periodically inspect stored products to ensure that products are being stored as stipulated and that they are free from damage and deterioration.
1. Any damaged or deteriorated materials must be replaced immediately to avoid delays in the project schedule.
- C. Do not remove items from storage until they are to be incorporated into the Work.
- D. The Contractor shall ensure that all protective wrappings and coverings are secure and ballasted to prevent any items from deterioration and/or subsequent dislodgment. All items on the work site that are subject to becoming windborne shall be ballasted or anchored.

**3.02 HANDLING AND TRANSPORTATION**

- A. Handling:
1. Avoid bending, scraping, or overstressing products. Protect projecting parts by blocking with wood, by providing bracing or by other approved methods.
  2. Protect products from soiling and moisture by wrapping or by other approved means.
  3. Package small parts in containers such as boxes, crates, or barrels to avoid dispersal and loss. Firmly secure an itemized list and description of contents to each container.
- B. Transportation:
1. Conduct the loading, transporting, unloading, and storage of products so that they are kept clean and free from damage.

**3.03 STORAGE**

- A. Store items in a manner that shall prevent damage to DEN's property. Do not store hydraulic fluids, gasoline, liquid petroleum, gases, explosives, diesel fuel, and other flammables in excavations. Petroleum products and chemicals must be stored in closed containers within secondary containment.
- B. Provide sheltered weather-tight or heated weather-tight storage as required for products subject to weather damage.
- C. Provide blocking, platforms or skids for products subject to damage by contact with the ground.
- D. All material shall be stored according to the manufacturer's recommendations. Any material that has to be stored within specified temperature or humidity ranges shall have a 24-hour continuously written recording made of the applicable condition. Should the recording show that the material was not stored within the recommended ranges the material shall be considered defective and in nonconformance. If a certification from the manufacturer's engineering design representative is provided stating that the actual variations are acceptable and will in no way harm the material or affect warranties, then the deficiency will be considered corrected.
- E. Store hazardous material separately, with all material marked with a label showing the hazard and how to treat exposure to the material. Store incompatible materials separately.

- F. Extra materials that are left over at the completion of the Work shall be removed from the Project site by the Contractor unless they are required to be delivered to DEN as per Contract Document requirements for maintenance stock.

**3.04 LABELS**

- A. Flammable and combustible substances shall be stored in flammable storage cabinets that conform to OSHA requirements and shall be labeled "FLAMMABLE - KEEP FIRE AWAY" and "NO SMOKING".

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 016610**

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**TECHNICAL SPECIFICATIONS  
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SECTION 016610 –STORAGE AND PROTECTION**

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**SECTION 017330**  
**CUTTING AND PATCHING**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Refer to Article 316, Cutting and Patching the Work in the General Contract Conditions, 2011 Edition

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Phased construction.
  - 4. Work by DEN.
  - 5. Work under separate contracts.
  - 6. Future work.
  - 7. Purchase contracts.
  - 8. DEN-furnished products.
  - 9. Contractor-furnished, DEN-installed products.
  - 10. Access to site.
  - 11. Coordination with occupants.
  - 12. Work restrictions.
  - 13. Specification and drawing conventions.
  - 14. Miscellaneous provisions.
- B. Related Requirements:
  - 1. Section 015210 "Temporary Facilities" for limitations and procedures governing temporary use of DEN's facilities.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

**1.03 DEFINITIONS**

- A. Cutting: Removal of existing construction to permit installation of or to perform other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Cutting and Patching Proposal: Submit a proposal describing procedures at least thirty (30) calendar days before the time cutting and patching will be performed, requesting approval to proceed. Obtain approval of the cutting and patching proposal by DEN Project Manager before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work or repair of other work damaged by unsatisfactory work. The proposal shall include at least the following information:
1. Identification of the Contract and the Contractor's name.
  2. Description of proposed work:
    - a. Scope of cutting, patching, alteration, or excavation.
    - b. The necessity for cutting or alteration.
    - c. Drawing showing location of the requested cutting or alteration, along with radar or x-ray report.
    - d. Trades that will execute the work.
    - e. Products proposed to be used.
    - f. Extent of refinishing to be done.
    - g. Alternatives to cutting and patching.
  3. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
  4. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted and proposed dates of interruption of service. Additionally, verify and locate anything in or behind the area prior to cutting.
  5. Proposed Dust Control and Noise Control Measures: Submit a statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
  6. Effect on the work and other surrounding work or on structural or weatherproof integrity of Project.
  7. Written concurrence of each contractor or entity whose work will be affected.
  8. Cost proposal, when applicable.

## **1.05 QUALITY CONTROL**

- A. Operational Elements: Do not cut and patch ANY operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance, decreased operational life or safety unless approved by the DEN Project Manager. Operations elements may include, but are not limited to the following:
1. Primary operational systems and equipment.
  2. Air or smoke barriers.
  3. Fire protection systems.
  4. Control systems.
  5. Communication systems.
  6. Conveying systems.

7. Electrical wiring systems.
  8. Operating systems of special construction as described in Divisions 13 and 26.
  9. HVAC systems.
- B. Miscellaneous Elements: Do not cut and patch ANY of the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or those results in increased maintenance, decreased operational life or safety unless approved by the DEN Project Manager. Miscellaneous elements may include, but are not limited to the following:
1. Water, moisture, or vapor barriers.
  2. Membranes and flashings.
  3. Exterior curtain wall construction.
  4. Equipment supports.
  5. Piping, ductwork, vessels and equipment.
  6. Noise control and vibration control elements and systems.
  7. Stud walls.
  8. Roofing system
- C. Visual Elements: Do not cut and patch ANY construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would reduce, in DEN's sole opinion, the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactorily manner.
1. If possible, retain the original installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage the original installer or fabricator, engage another recognized, experienced, and specialized firm as approved by the DEN Project Manager. Visual elements may include, but are not limited to:
    - a. Stonework and stone masonry.
    - b. Ornamental metal.
    - c. Matched-veneer woodwork.
    - d. Preformed metal panels.
    - e. Firestopping.
    - f. Window wall systems.
    - g. Terrazzo.
    - h. Flooring.
    - i. Wall coverings and finishes.
    - j. HVAC enclosures, cabinets, or covers.
- D. Cutting and Patching Conference: Before proceeding, meet at the Project site with all parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

## **1.06 WARRANTY**

- A. Existing Warranties: Remove, replace, patch and repair materials and surfaces cut or damaged during cutting and patching operations by methods and with materials so as not to void existing warranties.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 017330 – CUTTING AND PATCHING****DENVER INTERNATIONAL AIRPORT**  
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1. All effort shall be made to engage the original installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage the original installer or fabricator, engage another recognized, experienced and specialized firm as approved by the DEN Project Manager:
  - a. Processed concrete finishes.
  - b. Stonework and stone masonry.
  - c. Ornamental metal.
  - d. Matched-veneer woodwork.
  - e. Preformed metal panels.
  - f. Firestopping.
  - g. Window wall systems.
  - h. Terrazzo.
  - i. Flooring.
  - j. Wall coverings and finishes.
  - k. HVAC enclosures, cabinets, or covers.

**1.07 MATERIALS**

- A. General: All patching material shall be of the type specified for the material being patched. Comply with requirements specified in other specifications Sections.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually and texturally match existing adjacent surfaces to the fullest extent possible.
  1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials as approved by the DEN Project Manager.:

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers. Provide additional substrates or materials if required to achieve desired final results of patching work.
  2. Immediately notify the DEN Project Manager, in writing, of unsuitable, unsafe, or unsatisfactory conditions.
  3. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.
  4. Proceed with patching only after construction operations requiring cutting are complete and inspected by the DEN Project Manager.

**3.02 PREPARATION**

- A. Temporary Support: Provide temporary support of Work to be cut to ensure structural value

or integrity.

- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid or minimize interruption of services to occupied areas. Do not interrupt services in without approval from the appropriate authority. Refer to the appropriate Shutdown specification/procedures for applicable services.

### **3.03 POLLUTION CONTROLS**

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt.
  - 1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions such as ice, flooding, and pollution.
  - 2. For outdoor concrete saw cutting operations, slurry waste must be vacuumed up immediately to prevent migration off-site to pervious surfaces, surface waters or drains.
- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 1. Concrete slurry waste must be disposed of properly in accordance with applicable airport, local and state rules and regulations.
- C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to the condition existing before selective demolition operations began.

### **3.04 PERFORMANCE**

- A. General: Employ skilled workers to perform cutting and patching. Execute cutting and demolition by methods that will prevent damage to other work and will provide a proper surface to receive patching.
  - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
  - 2. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerance, and finishes.
  - 3. Restore work that has been cut or removed; install new products to provide complete work in accordance with requirements of the Contract Documents.
  - 4. Fit work airtight and fire safe to pipes, sleeves, ducts, conduit, and other penetrations through surfaces as required by the Contract Documents.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and other similar operations, including excavation, using methods least likely to damage elements retained to adjoining construction. If possible, review proposed procedures with original installer and comply with original installer's written recommendations.

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1. In general, use ground fault hand or small power tools designed (to short if metal is hit) for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete: Use a cutting machine such as an abrasive saw or a diamond-core drill.
  4. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other specification Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. For continuous surfaces, refinish entire unit to the nearest break line. For an assembly, refinish entire unit.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs on a painted surface, apply primer and intermediate paint coats over the patch and apply the final coat over the entire unbroken surface containing the patch. Provide additional coats until the patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
- D. Fire Rated Construction: Where rated elements are cut, reconstruct to approved designs to provide original fire rating.

**3.05 CORE DRILLING**

- A. The Contractor shall execute sufficient x-rays or ground penetrating radar (GPR) at each location planned for core drilling prior to submittal to the DEN Project Manager and to utility representatives for approval for core drilling. The request for approval shall be submitted a minimum seven (7) days before Core Drilling. The request for approval shall indicate on the x-ray or radar information regarding alternate locations or core drilling to avoid structural members and any embedded conduit. Embedded conduit may be metallic or plastic. The x-ray or radar system shall be capable of detecting both types of conduit.
- B. Core drilled “cores” and the core-drilled opening shall be inspected by DEN Project Manager Representatives prior to installation of any systems in new openings.
- C. The request for approval shall indicate on the x-ray or radar information regarding alternate locations or core drilling to avoid structural members and any embedded conduit. Embedded conduit may be metallic or plastic. The x-ray or radar system shall be capable of detecting both types of conduit.
- D. X-ray activities may not be performed during hours of activity or occupancy in the area of

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the x-ray system. The Contractor shall provide all manpower and barriers required to secure the areas affected by x-ray activities.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017330**

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**SECTION 017419****CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This section describes the requirements for the disposal, recovery, reuse or recycling of non-hazardous and non-asbestos containing construction and demolition waste for both LEED or Envision and non-LEED or Envision projects. Note that LEED and Envision projects may have more specific requirements than identified in this section.
- B. Waste materials shall be managed in accordance with all local, state, and federal regulations.
- C. Related Requirements:
1. Section 013300 "Submittal Procedures" for submittal procedures.
  2. Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.

**1.03 DEFINITIONS**

- A. Solid Waste: means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, air pollution control facility, or other discarded material; including solid, liquid, semisolid, or contained gaseous material resulting from industrial operations, commercial operations or community activities. Solid waste does not include any solid or dissolved materials in domestic sewage, or agricultural wastes, or solid or dissolved materials in irrigation return flows, or industrial discharges which are point sources subject to permits under the provisions of the "Colorado Water Quality Control Act", Title 25, Article 8, CRS or materials handled at facilities licensed pursuant to the provisions on "Radiation Control Act" in Title 25, Article 11, CRS. Solid waste does not include:
1. Materials handled at facilities licensed pursuant to the provisions on radiation control in Article 11 of Title 25, C.R.S.
  2. Excluded scrap metal that is being recycled.
  3. Shredded circuit boards that are being recycled.
- B. Salvaged Materials: Defined as materials that exist on the site that can be reused, either on site or by another entity
- C. Recyclable Materials: Defined as materials that exist on site or are generated during the construction process that can be recycled and/or remanufactured into another material. Recyclable waste includes, but is not limited to, the following:
1. Concrete.
  2. Asphalt
  3. Ferrous and non-ferrous metals.

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**TECHNICAL SPECIFICATIONS**  
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4. Untreated wood, engineered wood.
  5. Gypsum wallboard.
  6. Corrugated cardboard, paper goods.
  7. Plastic.
  8. Glass, insulation.
  9. Carpet.
  10. Paints, fabric.
  11. Rubber.
  12. Stone and brick.
- D. Hazardous Waste: Per 6 CCR 1007-3, those substances and materials defined or classified as such by the Hazardous Waste Commission pursuant to 25-15-302, C.R.S., as amended. Also, see hazardous waste definition per 40 CFR 261.3.
- E. Asbestos Containing Materials: Per 5 CCR 1001-10: Regulation No. 8, The Control of Hazardous Air Pollutants, Part B The Control of Asbestos- material containing more than 1% asbestos

**1.04 SUBMITTALS**

- A. The Contractor shall submit a list of materials and products used with Safety Data Sheets (SDS). Examples include chemicals, solvents, fuels, building materials, etc.
1. A hardcopy or electronic link to the SDS for all materials and products used, if applicable.
  2. Identify storage methods for materials, including measures to segregate incompatible materials.
- B. The Contractor shall submit a Waste Management Plan to the DEN Project Manager and DEN Environmental Services. Minimum Waste Management Plan requirements include the following:
1. A list of all waste streams generated by the project
    - a. For each waste stream listed, the Contractor shall identify the handling/transportation method, the disposal method, and the disposal facility utilized.
    - b. If the Contractor anticipates generation of hazardous waste, the Contractor shall provide its USEPA (generator) identification number.
  2. Pollution Prevention Measures
    - a. Describe best practices that will reduce waste. For example, waste reduction measures, requiring vendors to deliver materials in reusable packaging, etc.
  3. Waste Management Plan Training.
  4. Storage of materials.
  5. Spill response.
- C. Approval of Contractor's Waste Management Plan does not relieve the contractor of responsibility for compliance with applicable environmental regulations.
1. The contractor shall maintain a record of the amounts of construction and demolition waste generated, recycled, reused, salvaged, or disposed of, in pounds for review.

2. Hauling manifest records shall be maintained and available for review. Manifest forms are available from the DEN Project Manager.

## **PART 2 - PRODUCTS**

### **2.01 DOCUMENTS**

- A. A list of all materials and products used. Examples include chemicals, solvents, solvents, fuels, curing compounds, etc.
  1. A hardcopy or electronic link to SDSs for all materials and products used.
  2. Identify storage methods, including measures to segregate incompatible materials.
  3. Refer to the Waste Management Plan

## **PART 3 - EXECUTION**

### **3.01 REQUIREMENTS**

- A. The Contractor shall not wash down equipment in such a manner as to flush grease, oils, detergents, and other contaminants onto the project site or onto airport property unless the waste is properly contained, treated, and disposed of.
- B. DEN maintains two dry concrete and asphalt recycling yards used for the accumulation and crushing of asphalt and concrete. The South Yard is located on 71st Ave just east of Jackson Gap Street. The North Yard is located on the south side of 110th, west of Queensburg Street.
- C. Concrete washwater cannot be discharged to surface waters or to storm sewer systems. Colorado Discharge Permit System (CDPS) coverage conditionally authorizes discharges to the ground of concrete wash water from washing of tools and concrete mixer chutes when appropriate best management practices (BMPs) are implemented.
  1. A bermed containment area that allows discharge water to infiltrate or evaporate;
    - a. Alternatives to bermed containment areas include portable concrete washout bins, and industrial washout containment systems where the accumulated waste is removed from the site and disposed of properly.
  2. Use of the washout site should be temporary (less than one year);
  3. The washout site should not be located in an area where shallow groundwater may be present, such as near natural drainages, springs, or wetlands
  4. Upon termination of the washout site, accumulated solid waste, which includes concrete waste and contaminated soils, must be removed from the site and disposed of properly.
- D. Rejected loads and/or other wet concrete or asphalt materials are **PROHIBITED TO BE PLACED ANYWHERE** on DEN property. These materials must be returned to the facility of origination or other permitted facility for proper disposal.
- E. Concrete saw cutting slurry must be properly contained and disposed of.
- F. Unknown or questionable materials encountered during construction activities, must immediately be reported to the DEN Communications Center at (303) 342-4200 and the DEN Project Manager.

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**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017419**

**SECTION 017420****CLEANING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this section consists of maintaining a clean, orderly, hazard free work site during construction, and final cleaning for the City's Final Acceptance. Failure to maintain the work site will be grounds for withholding monthly payments until corrected to the satisfaction of the DEN Project Manager.
- B. Refer to Article 325, Cleanup During Construction in the General Contract Conditions, 2011 Edition

**1.03 SUBMITTALS**

- A. Washing Plan: The Contractor shall prepare a plan describing the specific procedures and materials to be utilized for any equipment, vehicle, etc., washing activities. The plan must be submitted to the DEN Project Manager and approved by the DEN Project Manager and Environmental Services.
  - 1. Outdoor washing at DEN is not allowed unless the materials will be collected or managed in a manner to ensure that they will not enter the municipally owned separate storm sewer system (MS4). The materials can only be disposed at a location pre-approved by DEN Environmental Services (refer to DEN SWMP). Failure to comply with this requirement would result in the discharge of non-stormwater.
    - a. Outdoor wash materials that contain soaps or other cleaning chemicals must be collected and disposed of off site
  - 2. Indoor washing must be conducted in accordance with the Best Management Practices (BMPs) detailed in the DEN SWMP. Refer to Section 015719 "Environmental Controls". In addition, all indoor washing must be conducted in a manner that ensures that there are no prohibited discharges to the sanitary sewer system.
    - a. All wash-water that will be disposed of into the sanitary sewer must comply with City and County Denver rules and regulations pertaining to prohibited discharges.

**PART 2 - PRODUCTS****2.01 CLEANING MATERIALS**

- A. Utilize the type of cleaning materials recommended by the manufacturer for the surfaces to be cleaned.
- B. Maintain current Safety Data Sheets (SDS) on site for all chemicals. DEN Environmental Services must approve the chemicals used prior to discharge to the sanitary sewer system.

- C. Ensure proper disposal of all wastes generated from the use of these materials. The Contractor must ensure compliance with all environmental regulations. No wastes can be disposed of on DEN property.

## **PART 3 - EXECUTION**

### **3.01 INTERIM CLEANING**

- A. Clean only when dust and other contaminants will not precipitate upon newly painted surfaces.
- B. Cleaning shall be done in accordance with manufacturer's recommendation.
- C. Cleaning shall be done in a manner and using such materials as to not damage the Work.
- D. Clean areas prior to painting or applying adhesive.
- E. Clean all heating and cooling systems prior to operations. If the Contractor is allowed to use the heating and cooling system, it shall be cleaned prior to testing.
- F. Clean all areas that will be concealed prior to concealment.
- G. Dispose of all fluids according to the approved Washing Plan.

### **3.02 FINAL CLEANING**

- A. Refer to Article, Clean-up Upon Completion in the General Contract Conditions, 2011 Edition. Additionally, the Contractor, shall at a minimum, complete the following:
  - 1. Inspect interior and exterior surfaces, including concealed spaces, in preparation for completion and acceptance.
  - 2. Remove dirt, dust, litter, corrosion, solvents, discursive paint, stains, and extraneous markings.
  - 3. Remove surplus materials, except those materials intended for maintenance.
  - 4. Remove all tools, appliances, equipment, and temporary facilities used in the construction.
  - 5. Remove detachable labels and tags. File them with the manufacturer's specifications for that specific material for the City's records.
  - 6. Repair damaged materials to the specified finish or remove and replace.
  - 7. After all trades have completed their work and just before Final Acceptance, all catch basins, manholes, drains, strainers and filters shall be cleaned; roadway, driveways, floors, steps and walks shall be swept. Interior building areas shall be vacuum cleaned and mopped.
  - 8. Final cleanup applies to all areas, whether previously occupied and operational or not.
  - 9. Dispose of all fluids according to the approved Washing Plan.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

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**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017420**

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**SECTION 017515****SYSTEM STARTUP, TESTING AND TRAINING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Provide complete startup, testing, and operator training services to ensure operability of all systems supplied.
- B. Coordinate all start-up and testing with DEN's Commissioning consultant and/or DEN Asset Management through the DEN Project Manager.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures. Submit the following:
  - 1. Test procedures.
  - 2. Test reports.
  - 3. Training outline.
- B. Submit Qualification Data: For facilitator, instructor, and videographer.
- C. Attendance Record: For each training module submit the following:
  - 1. Module title
  - 2. Module description
  - 3. Length of instruction time
  - 4. Participant names
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

**1.04 QUALITY ASSURANCE**

- A. Facilitator Qualifications: A firm or individual experienced in training or educating personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required. Recordings shall be high-resolution 1080p with a minimum framerate of 60Hz

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- D. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Section 014510 "Contractor Quality Control". Review methods and procedures related to demonstration and training including, but not limited to, the following:
1. Inspect and discuss locations and other facilities required for instruction.
  2. Review and finalize instruction schedule and verify availability of educational materials, instructor's personnel, audiovisual equipment, and facilities needed to avoid delays. Ensure that students are notified at least 14 [insert other] days prior to the start of instruction.
  3. Review required content of instruction.
  4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

**1.05 COORDINATION**

- A. Coordinate instruction schedule with DEN's operations. Adjust schedule as required to minimize disrupting DEN's operations and to ensure availability of DEN's personnel. As required, include multiple classed to accommodate various shifts
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by DEN Project Manager.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 FIELD TESTS AND ADJUSTMENTS**

- A. All electrical and mechanical equipment including the interfaces with control systems and the communication system, and all alarm and operating modes for each piece of equipment, shall be tested by the Contractor to the satisfaction of the DEN Project Manager before any facility is put into operation. Tests shall be as specified herein and shall be made to determine whether the equipment has been properly assembled, aligned and connected. Any changes, adjustments, or replacements required to make the equipment operate as specified shall be carried out by the Contractor as part of the Work.
  1. At least thirty (30) days before the time allowed in the construction schedule for commencing startup and testing procedures, the Contractor shall submit to the DEN Project Manager three (3) copies of the detailed procedures the Contractor proposes for testing and startup of all electrical and mechanical equipment. These procedures are submitted for review and acceptance by DEN.
  2. The Contractor's startup and testing procedures shall include detailed descriptions of all pre-operational hardware, electrical, mechanical and instrumentation used for testing work.
    - a. Each control device, item of electrical, mechanical and instrumentation equipment, and all control circuits shall be considered in the testing procedures which shall be designed in a logical sequence to ensure that all equipment has been properly serviced, aligned, connected, wired, calibrated and adjusted prior to operation.
    - b. Motors shall be tested in accordance with ANSI/IEEE Publication 112. The

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Contractor is advised that failure to observe these precautions may place the acceptability of the subject equipment in question, and the Contractor may either be required to demonstrate that the equipment has not been damaged, or replace it as determined by the DEN Project Manager.

3. Testing procedures shall be designed to duplicate as nearly as possible all conditions of operations and shall be carefully selected to ensure that the equipment is not damaged. All filters shall be in place during startup and testing.
    - a. Once the DEN Project Manager has accepted the testing procedures, the Contractor shall provide checkout, alignment, adjustment and calibration signoff forms for each item of equipment and each system that will be used.
    - b. The Contractor and the DEN Project Manager shall use the signoff forms in the field jointly to ensure that each item of electrical, mechanical and instrumentation equipment and each system has been properly installed and tested. The Contractor shall cooperate with project-wide systems contractors where startup and testing is to be conducted concurrently.
  4. Any special equipment needed to test equipment shall be provided by the Contractor to the City at no cost for a period of thirty (30) days during startup.
- B. Before starting up the equipment, the Contractor shall properly service it and other items, which normally require service in accordance with the maintenance instructions. The Contractor shall be responsible for lubrication and maintenance of equipment and replacement filters throughout the entire equipment “break-in” period described by the manufacturer.
1. The Contractor shall be responsible for the startup, adjustment, preliminary maintenance, and checkout of all equipment and instrumentation. All systems shall be carefully checked for conformance with the design criteria.
  2. If any equipment or system does not operate as specified in the Contract, the Contractor shall immediately replace or repair components until it operates properly.
  3. The Contractor shall submit a test report to the DEN Project Manager within thirty (30) days after completion of the system startup period.

**3.02 SYSTEMS STARTUP AND TESTING**

- A. The Contractor shall be responsible for a 30-day startup period during which time all hardware, electrical and mechanical equipment, communications, alarm systems, and associated devices shall be energized and operated under local and automatic controls. The Contractor shall be present during the startup period with adequate labor and support personnel to adjust equipment and troubleshoot system failures that might arise.
- B. When a piece of electrical or mechanical equipment is found to be in conflict with specific criteria, an experienced representative of the manufacturer shall adjust the item.
- C. If adjustments fail to correct the operation of a piece of equipment or fixture, the Contractor shall remove the equipment or fixture from the Project site and replace it with a workable replacement that meets the specification requirements.
- D. The 30-day startup period shall commence thirty (30) days prior to the Contract completion date and shall be completed prior to final payment. If, during the startup, any system fails to operate in accordance with Contract requirements, the failure shall be corrected and the startup period shall begin again.
  1. At the end of the startup period, all filters shall be replaced with new ones.
  2. The City may provide, at its option, a Commissioning Representative to observe or participate in the startup and testing of any system. The Contractor shall coordinate

with the Commissioning Representative relating to scheduling, reporting, forms, methods, and procedures of the startup and testing.

### **3.03 FINAL INSTRUCTIONS AND OPERATION TRAINING**

- A. After startup and testing is completed, the Contractor shall demonstrate to the City's personnel the proper manner of operating the equipment, programming messages, making adjustments, responding to alarms and emergency signals, and maintaining the system.
- B. The Contractor shall provide on-the-job training by a suitably qualified instructor to designated personnel and shall instruct them in the operation and maintenance of the systems. In the event qualified instructors on the Contractor's staff are not available, the Contractor shall arrange with the equipment manufacturer for such instruction at no additional cost to the City.
- C. The Contractor shall provide a minimum of eight (8) hours of operator training to the Airport per shift. Classes shall accommodate up to five (5) people at a time with up to two (2) separate courses (one for each shift).
- D. The Contractor shall provide a syllabus to the DEN Project Manager at least seven (7) calendar days prior to the start of each course that outlines topics to be covered, the proposed time allotted to each topic, and the target audience of the training session (technical, casual operator, overview, etc.). The Contractor shall not commence any training courses until the syllabus has been reviewed and approved by the DEN Project Manager.
- E. The Contractor shall video record all training sessions and provide to the DEN Project Manager. The Contractor shall provide video recordings in format as required in Section 017900 "Demonstration and Training".
- F. The Contractor shall provide an annotated syllabus to the DEN Project Manager that indicates topics contained on each tape.
- G. The contractor shall provide instruction for obtaining live help for questions relating operation and troubleshooting.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017515**

**SECTION 017720**  
**CONTRACT CLOSEOUT**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Special Sections, apply to this Section.

**1.02 SUMMARY**

- A. Work specified in this Section includes procedures required prior to Final Acceptance of the Work in addition to those specified in Title 20 – Final Completion and Acceptance of The Work in the General Contract Conditions, 2011 Edition, and Technical Specification Section 017840 "Contract Record Documents".
- B. This Section also includes procedures and penalties to ensure prompt completion of the Project Closeout.
- C. Related Sections:
1. Title 20 of the General Contract Conditions, 2011 Edition..
  2. Section 017840 "Contract Record Documents" for required record documents.
  3. Form CM-75, Closeout Checklist
- D. SUBMITTALS
1. Submit written Certification to the DEN Project Manager that, in the opinion of the Contractor, the Work is complete.
  2. Submit final survey within 60 days after issuance of Substantial Completion.
  3. Submit a Final Statement of Accounting to the DEN Project Manager.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PREPARATION FOR FINAL INSPECTION**

- A. Before requesting inspection for Final Acceptance of the Work by the City, the Contractor shall inspect, clean, and repair the Work as required.
- B. The Contractor shall ensure that all items on the Closeout Checklist have been addressed and accepted by the DEN Project Manager.

**3.02 FINAL INSPECTION**

- A. The Contractor shall submit written certification to the DEN Project Manager when, in the opinion of the Contractor, the Work is complete. Such communication shall certify that:
1. The Work has been inspected by the Contractor for conformance with the Contract Documents.

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2. The Work has been completed in conformance with the Contract Documents, including all punchlist items.
  3. The Work is ready for final inspection by the City.
  4. All as-built documents have been submitted and accepted.
  5. All damaged or destroyed real, personal, public, or private property impacted by the Work has been repaired or replaced.
  6. All Warranties and Bonds have been completed, executed, submitted, and accepted.
  7. All personnel badges and vehicle permits have been returned to DEN Airport Security.
- B. The DEN Project Manager will inspect the Work in accordance with the Section 2002.1 of the City and County of Denver's Department of Aviation's General Contract Conditions.
- C. If the DEN Project Manager finds incomplete or defective Work:
1. The DEN Project Manager may, at the DEN Project Manager's sole discretion, either terminate the inspection, or prepare a punchlist and notify the Contractor in writing, listing the incomplete or defective Work.
  2. The Contractor shall take immediate steps to remedy all identified deficiencies and resubmit a written certification to the DEN Project Manager that Work is complete.
  3. The DEN Project Manager will then re-inspect the Work.

### 3.03 REINSPECTION FEES

- A. Should the DEN Project Manager be required to perform re-inspections of the Work due to the Contractor prematurely claiming the status of the Work to be complete:
1. The Contractor shall compensate the City for such additional services at the per-hour rates defined below, for the time spent by the DEN Project Manager on re-inspection and related work, with a minimum charge of \$250:

<b>Position</b>	<b>Rate</b>
Project Manager	\$150
Quality Assurance Inspector	\$125
Commissioning Agent	\$125

2. The City shall deduct the amount of such compensation from the final payment to the Contractor.

### 3.04 FINAL SURVEY FEES

- A. The Contractor shall complete and submit the final survey within 60 days after issuance of Substantial Completion. If the Contractor fails to complete and submit the final survey within this time frame it is understood that DEN will arrange for a qualified surveying company to complete this work at the Contractor's expense. All costs associated with DEN arranging for and completing the final survey will be deducted from the final payment including compensation due the City for the DEN Project Manager's time to manage this work.
1. The DEN Project Manager's rate of compensation shall be set at \$150.00 per man-hour.
  2. Survey submittals needing to be revised may extend the 60-day time frame at the DEN Project Manager's discretion.
  3. Costs, including the DEN Project Manager's, for the review of the resubmitted survey shall be deducted from the final payment.

**3.05 LATE CLOSEOUT FEES**

- A. Within 100 days after issuance of substantial completion, all documentation required by this Contract to achieve Project Closeout shall be submitted. Failure to submit all required documentation shall result in fees to compensate the City for project management work while the project remains open. These shall be assessed if no liquidated damages are provided or and paid for late completion.
1. Fees at the rate of \$450 per day to compensate for additional DEN Project Manager, consultant, and other personnel's work.
  2. The resubmittal of required documents may extend the 100-day time frame at the DEN Project Manager's discretion.

**3.06 FINAL ADJUSTMENT OF ACCOUNTS**

- A. Submit a Final Statement of Accounting to the DEN Project Manager.
- B. The Final Statement of Accounting shall reflect all adjustments to the Contract amount and shall include the following:
1. The original Contract Value.
  2. Additions and deductions resulting from the following:
    - a. Approved Change Orders.
    - b. Allowances.
    - c. Final quantities for unit price items, including required backup for the quantities.
    - d. Deductions for corrected work.
    - e. Penalties.
    - f. Deductions for liquidated damages.
    - g. Deductions for re-inspection payments.
    - h. Other adjustments.
  3. Total Contract Value, as adjusted.
  4. Previous payments.
  5. Sum remaining due.
- C. If required, the DEN Project Manager will prepare a final Change Order, reflecting the approved adjustments to the Contract Value that were not included in previously issued Change Orders.

**3.07 FINAL APPLICATION FOR PAYMENT**

- A. The Contractor shall submit the final application for payment in accordance with the procedures and requirements detailed in Article 2003, Final Settlement in the General Contract Conditions, 2011 Edition.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

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**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017720**

**SECTION 017825****OPERATION AND MAINTENANCE DATA****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparing and submitting operation and maintenance data for mechanical, electrical, and other specified equipment/products.
- B. Coordinate all the requirements of the required data with DEN Asset Management.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. All submittals must be provided in electronic data as indicated by the DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and as required by the DEN BIM and DEN Asset Management groups.
- C. Submit one (1) electronic copy and three (3) bound hard copies of the proposed Operation and Maintenance Data Manual not less than 30 days prior to acceptance tests and final inspection.
  - 1. The submitted copies shall provide the Information following the MasterFormat standard. Equipment/Data shall be organized using Section formatting within the 50 MasterFormat Divisions.
- D. Submit one (1) electronic copy and three (3) bound hard copies of Operation and Maintenance Data Manual within ten days after acceptance tests and final inspection is complete. These copies shall incorporate any comments made on the previous submittals, along with final readings on all settings and gauges taken while the system is in fully satisfactory operation.

**1.04 CONTINUOUS UPDATING PROGRAM**

- A. Furnish to DEN AIM Asset Management one (1) electronic copy of the Contractor's letter indicating that suppliers have been notified to provide updated operation and maintenance data, service bulletins, and other information pertinent to the equipment to DEN, as it becomes available.

**PART 2 - PRODUCTS****2.01 OPERATIONS AND MAINTENANCE MANUAL REQUIREMENTS**

- A. The following products are the requirements of hard copies:
  - 1. Paper size: 8-½ inches x 11 inches.

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2. Paper: White bond, at least 20-pound weight.
3. Text: Typewritten.
4. Printed data: Manufacturer's catalog cuts, brochures, operation, and maintenance data. Clear reproductions thereof will be acceptable. If this data is in color, all final manuals must contain color data.
5. Drawings: 8½ inches x 11 inches, bound with the text. Larger drawings are acceptable provided they are folded to fit into a pocket inside the rear cover of the manual. Reinforce edges of large drawings.
6. Prints of drawings: Black ink on white paper, sharp in detail and suitable for making reproductions.
7. Flysheets: Separate each portion of the manual with colored, neatly prepared flysheets briefly describing the contents of the ensuing portion.
8. Covers: Provide 40 to 50 mil, clear plastic, front and plain back covers for each manual. The front covers shall contain the information required in paragraph 3.2 below.
9. Bindings: Conceal the binding mechanism inside the manual. Lockable 3-ring binders shall be provided.
10. Training Videos: Provide in digital electronic format as per current DEN requirements.
  - a. Refer to Section 017900 - Demonstration and Training for video requirements.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Assemble each operation and maintenance manual using the manufacturer's latest standard commercial data, and include all additional information that is unique to the Project.

**3.02 COVER**

- A. Include the following information on the front cover and on the inside cover sheet:
  1. Operation and maintenance instructions.
  2. Title of structure or facility.
  3. Title and number of Contract.
  4. Contractor's name and address.
  5. General subject of the manual.

**3.03 CONTENTS OF THE MANUAL**

- A. Table of Contents, which references, at a minimum, three heading levels.
- B. Index of Equipment/Data with entries for equipment type and MasterFormat Division and Section.
- C. A Master Index that contains index entries for all submitted Operation and Maintenance Data Manuals.
  1. Equipment/Data shall be indexed by equipment type and MasterFormat Division and Section.

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2. Name, address, and telephone numbers of Contractor, suppliers and installers along with the manufacturer's order number and description of the order.
3. Name, address, and telephone numbers of manufacturer's nearest service representatives.
4. Name, address, and telephone number of nearest parts vendor and service agency.
5. Copy of guaranties and warranties issued to, and executed in the name of, the City.
6. Anticipated date the City assumes responsibility for maintenance.
7. Description of system and component parts including theory of operation.
8. Pre operation check or inspection list.
9. Procedures for starting, operating, and stopping equipment.
10. Post operation check or shutdown list.
11. Inspection and adjustment procedures.
12. Troubleshooting and fault isolation procedures for on-site level of repair.
13. Emergency operating instructions.
14. Accepted test data.
15. Maintenance schedules and procedures.
16. Test procedures to verify the adequacy of repairs.
17. One (1) copy of each wiring diagram.
18. One (1) copy of each piping diagram.
19. Location where all measurements are to be made.
20. One (1) copy of each duct diagram.
21. One (1) copy of control diagram.
22. One (1) copy of each accepted shop drawing.
23. One (1) copy of software programs imputable or changeable on site.
24. Ordering information.
25. Training course material used to train DEN staff, including slides and other presentation material.
26. Provide the following information, unless the item is covered in the Manufacturer's Operation and Manual:
  - a. Manufacturer's parts list with catalog names, numbers, and illustrations.
  - b. A list of components that are replaceable by the City.
  - c. An exploded view of each piece of the equipment with part designations.
  - d. List of manufacturer's recommended spare parts, current prices, and recommended quantities for two years of operation.
  - e. List of special tools and test equipment required for the operation, maintenance, adjustment, testing and repair of the equipment, instruments and components.
  - f. Scale and corrosion control procedures.
  - g. Disassembly and re-assembly instructions.
  - h. Troubleshooting and repair instructions.
  - i. Calibration procedures.

**PART 4 - MEASUREMENT**

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**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017825**

**SECTION 017835****WARRANTIES AND BONDS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparing and submitting warranties and bonds required by the Contract and these Specifications.

**1.03 SUBMITTALS**

- A. Refer to Technical Specifications Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
1. All warranties shall be executed or transmitted to the City and County of Denver.
  2. Photocopies or reproductions of stock manufacturer's warranties will not be accepted, although electronic copies are acceptable when the manufacturer's warranty is contained in the O&M manual.
- B. Submit samples of warranties and bonds for review by the City prior to execution of Work. Do not submit final warranties until sample warranties have been approved by the City.
1. Submit the warranties and bonds required by the Contract Documents.
  2. Prepare and submit a list of all warranties and bonds on the following forms:
    - a. CM-10: Contractor Warranty
    - b. CM-11: Contractor/Sub-Contractor Warranty
- C. Submit executed warranties and bonds.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 WARRANTIES AND BONDS**

- A. Submit executed warranties and bonds required by the Contract Documents, as detailed in Title 15 - Performance and Payment Bonds and Title 18 - Warranties, Guarantees, and Corrective Work in the General Contract Conditions, 2011 Edition.
1. Prepare and submit a list of all warranties and bonds on the following forms:
    - a. CM-10, Contractor Warranty
    - b. CM-11, Contractor/Sub-Contractor Warranty

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017835**

**SECTION 017840****CONTRACT RECORD DOCUMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of maintaining, marking, recording, and submitting Contract Record Documents that include shop drawings, warranties, and contractor records. Creating and providing to DEN these documents are part of the Work and become part of the Contract Documents.
- B. Refer to DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and Approved BIM execution for data format and file types acceptable for different type of data.
- C. Related Requirements:
1. Section 013100 "Project Management and Coordination".
  2. Section 013223 "Construction Layout, As-built and Quantity Surveys".
  3. Section 013300 "Submittal Procedures".
  4. Section 013325 "Shop and Working Drawings, Product Data and Samples".
  5. Section 017720 "Contract Closeout".
  6. Section 017825 "Operation and Maintenance Data".

**1.03 SUBMITTALS**

- A. Each submittal of record documents shall contain the following information:
1. Date.
  2. Project title and numbers.
  3. Contractor's name and address.
  4. Title and number of each record document.
  5. Certification that each document as submitted is complete and accurate.
  6. Signature of the Contractor or the Contractor's authorized representative.
- B. At the completion of this Contract, deliver all record documents including the following:
1. As-built shop drawings, diagrams, illustrations, schedules, charts, brochures and other similar data.
  2. Warranties, guarantees, and bonds.
  3. Contract Documents.
  4. Contractor records.

- C. As-built Contract Drawings shall be submitted with each monthly progress payment application, and a complete set shall be submitted prior to final payment.
  - 1. The Contractor shall provide a single electronic copy of each Contract drawing sheet which has been used to produce work during the payment period or work that payment is being requested on, which records the current as-built conditions of work, including the posting of any change orders or change directives not shown on the Contract Documents at the time of Contract signing.
    - a. The Contractor must show as-built work completed through the payment application date including but not limited to utilities, empty conduit, conduit for actual electrical lines, plumbing, HVAC, location of anchor bolts and support points for use by others.
    - b. The Contractor shall be liable for any costs incurred by the City or a third party due to errors or lack of information provided on the as-built drawings.
    - c. All markings on drawings shall be legible to identify the portion of work completed.
    - d. For projects utilizing BIM system by the Contractor or a consultant of the Contractor, all data formats shall be compatible and as approved by the BIM execution plan as required in the DEN BIM DSM.

#### **1.04 QUALITY CONTROL**

- A. Submit electronically scanned copies of all documents required by Chapter 17 “Special Inspection and Testing” of the International Building Code 2009 as amended by City and County of Denver 2011. Keep scale and clarify dimension where electronic copies are not as originally scaled and dimensioned.
- B. For projects utilizing BIM for Revit, follow approved BIM execution plan and DEN BIM DSM for record documents, formats, and quality control and assurance procedures.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.01 MAINTENANCE OF DOCUMENTS**

- A. The Contractor must follow all the procedures established in the Contract Documents and DEN BIM DSM.
- B. The Contractor shall maintain at the work site on a current basis one (1) record copy of all drawings, specifications, addenda, change orders, approved shop drawings, working drawings, product data and samples in good order and marked currently to record all changes made during construction.
- C. Maintain at the field office one copy of the following record documents:
  - 1. Contract Documents:
    - a. Contract Drawings with all clarifications, requests for information, directives, changes, and as-built conditions clearly posted.
    - b. Contract Specifications with all clarifications, requests for information, changes, directives and record of manufacturer actually used along with product trade name.
    - c. Reference Standards in accordance with Section 014225 "Referenced Standards".
    - d. Affirmative Action Plan and documents.

- e. One (1) set of drawings to record the following:
  - 1) Horizontal and vertical location of underground utilities affected by the Work.
  - 2) Location of internal utilities; include valves, controls, conduit, duct work, switches, pressure reducers, size reducers, transitions, crosses, tees, filters, motors, heaters, dampers, regulators, safety devices, sensors, access doors and appurtenances that are concealed in the construction shall be shown with dimensions given from a visible and recognizable reference to the item being located in all three dimensions. The drawings shall also reference the applicable submittal for the item being located.
  - 3) Field changes of dimensions and details including as-built elevations and location (station and offset).
  - 4) Details not on original Contract Drawings but obtained through requests for information or by other communications with the City.
2. Contractor Records:
  - a. Daily Quality Control Reports.
  - b. Certificates of compliance for materials used in construction.
  - c. Completed inspection list.
  - d. Inspection and test reports.
  - e. Test procedures.
  - f. Qualification of personnel.
  - g. Approved submittals.
  - h. Material and equipment storage records.
  - i. Safety Plan
  - j. Erosion, sediment, hazardous and quality plans.
  - k. Hazardous material records.
  - l. First report of injuries.

### **3.02 RECORDINGS**

- A. Label each document page or article "PROJECT RECORD" in two-inch high letters.
- B. Keep record documents current daily.
- C. Legibly mark copies of the Contract Drawings to record actual construction.
- D. Legibly mark up each Section of the specifications and Contract Drawings to record:
  1. Manufacturer, trade name, catalog number and supplier of each product and item actually installed
  2. Changes made by change orders, requests for information, substitutions, and variations approved by submittals.

### **3.03 DOCUMENT MAINTENANCE**

- A. Follow all the required processes of the approved BIM Execution Plan as approved by DEN for this specific project or in formats acceptable to DEN BIM management system.
- B. Do not use record documents for construction purposes.
- C. Make documents available for inspection by the DEN Project Manager and any others having jurisdiction.

### **3.04 MONTHLY REVIEW**

- A. Prior to any application for payment, the DEN Project Manager or the DEN Project Manager's designated representative will inspect the record documents to ensure that they are being maintained and contain the most current correct data with particular attention to as-built drawings.
  
- A. If, during the inspection, the DEN Project Manager determines that the documents are not being maintained and kept current so they reflect as-built conditions, an amount may be withheld from the payment request and deducted from the Contract value to cover the City's cost of collecting, creating, and recording the as-built data. This cost will be determined based on \$100.00 per man-hour of effort.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017840**

**SECTION 017900****DEMONSTRATION AND TRAINING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for instructing City's personnel, including the following:
1. Demonstration of operation of systems, subsystems, and equipment.
  2. Training in operation and maintenance of systems, subsystems, and equipment.
  3. Demonstration and training video recordings.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructor's names for each training module. Include learning objective and outline for each training module.
1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator, instructor, and videographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

**1.04 CLOSEOUT SUBMITTALS**

- A. Demonstration and Training Video Recordings: Submit two (2) copies within seven (7) days of end of each training module.
1. Identification: On each copy, provide an applied label with the following information:
    - a. Name of Project.
    - b. Name and address of videographer.
    - c. Name of Architect.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Date of video recording.
  2. Closed Caption: Videos shall contain a visible text version of all speech provided in the recording.

3. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
4. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
5. At completion of training, submit complete training manual(s) for City's use in PDF electronic file format.

### **1.05 QUALITY ASSURANCE**

- A. Facilitator Qualifications: A firm or individual experienced in training or educating personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A professional instructor/trainer who is experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Section 014510 "Contractor Quality Control". Review methods and procedures related to demonstration and training including, but not limited to, the following:
  1. Inspect and discuss locations and other facilities required for instruction.
  2. Review and finalize instruction schedule and verify availability of educational materials, instructor's personnel, audiovisual equipment, and facilities needed to avoid delays.
  3. Review required content of instruction.
  4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

### **1.06 COORDINATION**

- A. Coordinate instruction schedule with City's operations. Adjust schedule as required to minimize disrupting City's operations and to ensure availability of City's personnel.
  1. Include multiple classes to accommodate various shifts, as necessary.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by DEN Project Manager.

## **PART 2 - PRODUCTS**

### **2.01 INSTRUCTION PROGRAM**

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- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project record documents.
    - e. Identification systems.
    - f. Warranties and bonds.
    - g. Maintenance service agreements and similar continuing commitments.
  3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.
    - c. Shutdown instructions for each type of emergency.
    - d. Operating instructions for conditions outside of normal operating limits.
    - e. Sequences for electric or electronic systems.
    - f. Special operating instructions and procedures.
  4. Operations: Include the following, as applicable:
    - a. Startup procedures.
    - b. Equipment or system break-in procedures.
    - c. Routine and normal operating instructions.
    - d. Regulation and control procedures.
    - e. Control sequences.
    - f. Safety procedures.
    - g. Instructions on stopping.
    - h. Normal shutdown instructions.
    - i. Operating procedures for emergencies.
    - j. Operating procedures for system, subsystem, or equipment failure.
    - k. Seasonal and weekend operating instructions.
    - l. Required sequences for electric or electronic systems.
    - m. Special operating instructions and procedures.

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5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

**PART 3 - EXECUTION****3.01 PREPARATION**

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017825 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

**3.02 INSTRUCTION**

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and City for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct City's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  1. Contractor will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
  2. City will furnish an instructor to describe City's operational philosophy.
  3. DEN Project Manager will furnish Contractor with names and positions of DEN participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires

seasonal operation, provide similar instruction at start of each season.

1. Schedule training with City, through DEN Project Manager, with at a minimum of thirty (30) days advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test, as applicable and as required by the DEN PM.
- F. Cleanup: Collect used and leftover educational materials and give to DEN. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

### **3.03 DEMONSTRATION AND TRAINING VIDEO RECORDINGS**

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video Recordings: Submit video recordings in an electronic format acceptable to DEN Project Manager by posting to Project Web site. Recordings shall be high-resolution 1080p with a minimum framerate of 60Hz
1. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
  2. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project:
    - a. Name of Contractor/Installer.
    - b. Business address.
    - c. Business phone number.
    - d. Point of contact.
    - e. E-mail address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.
    - a. Produce segments to present a single significant piece of equipment per segment.
    - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.

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- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
1. Closed Caption: Videos shall contain a visible text version of all speech provided in the recording.
  2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
  3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Failure of Video Recordings: If video recordings submitted by Contractor do not comply with Project requirements, or have audio and/or video problems, Contractor will be required to repeat training and video recording in compliance with this Section in order to re-create the training video.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017900**

**SECTION 019113****GENERAL COMMISSIONING REQUIREMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Basis of Design (BOD) documentation included by reference for information only.
- C. Specification Sections:
  - 1. Section 013100 – Project Management and Coordination
  - 2. Section 013119 – Project Meetings
  - 3. Section 013300 – Submittal Procedures
  - 4. Section 014510 – Contractor Quality Control
  - 5. Section 221323 – Sanitary Waste Interceptors
  - 6. Section 333123 – Sanitary Sewerage Force Main Piping

**1.02 SUMMARY**

- A. Scope
  - 1. Commissioning requirements common to all Sections
  - 2. Systems and equipment functional performance testing
  - 3. Validation of proper and thorough installation of systems and equipment
  - 4. Equipment performance verification
  - 5. Documentation of tests, procedures, and observations.
  - 6. Review of DEN Training agency.
- B. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

**1.03 DEFINITIONS**

- A. Acceptance Phase: The phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and formal training occurs. This will generally occur after the Construction Phase is complete (start-up and checks have been accomplished). The Acceptance Phase typically begins with Substantial Completion and ends with Final I Completion.
- B. Basis of Design (BOD): A document that records concepts, calculations, decisions, and product selections used to meet the Contract and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- C. Commissioning Authority (CA or CxA): The Party retained by DEN who will oversee the

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- Commissioning process as well as develop and stipulate many of the Commissioning requirements. They will also manage the Commissioning process, and ensure and validate that systems and equipment are designed, installed, and tested to meet DEN's requirements.
- D. Commissioning Contact (CxC): Individuals, appointed by the installing contractor, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action.
- E. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- F. Construction Phase: Phase of the project during which the facility is constructed and/or systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete start-up documentation, submit operation and maintenance information, establish trends, and perform any other applicable requirements to get systems started. Contractor and Vendors may also conduct equipment specific training. The Construction Phase will generally end upon Substantial Completion.
- G. Contractor: As used herein, 'Contractor' is a general reference to the installing Party and can therefore refer to the General Contractor, subcontractors, or vendors as inferred by its usage.
- H. Deficiency: A condition in the installation or function of a component, piece of equipment or system that does not comply with the Contract Documents, i.e., does not perform properly or is not complying with the design intent.
- I. Energy Management Control System (EMCS): The computer-based heating, ventilation, and air-conditioning (HVAC) control system.
- J. Factory Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.
- K. Factory Testing: Testing of equipment off-site at the manufacturer's facility. The testing may be witnessed by the members of the project team.
- L. Functional Performance Testing (FPT): The detailed and thorough testing of building systems and their interactions with building components and other building systems.
- M. Issue Log: This list is maintained and updated by the Commissioning Authority that includes all Issue items that relate to Commissioning activities and site observations requiring contractor action or response.
- N. Maximum Failure Limit: The maximum percentage of a test population that is permitted to fail before the test is considered a failure and subject to correction and retesting. Where test sampling is used, the Maximum Failure Limit shall be the maximum percentage of a test sample that is permitted to fail before an entirely new sample must be selected for testing.
- O. Operation and Maintenance (O&M) Documentation: Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. This includes manufacturer's literature (including O&M manuals, parts lists, troubleshooting guides, etc.), Contractor-developed instructions for start-up and shut-down, control sequences, and other installation-specific information.
- P. Pre-Start Up: Preliminary testing accomplished during a scheduled system outage to verify system functionality prior to placing the system/equipment into preliminary service.

- Q. Start-Up: Refers to the quality control process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the Start-Up Checklist, energizes the device, verifies that it is in proper working order and ready for dynamic testing, including Start-Up Tests.
- R. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- S. Test, Adjust, and Balance (TAB): Refers to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor.
- T. Trending: Monitoring and recording a history of parameters typically using the EMCS.

#### **1.04 ACTION SUBMITTALS**

- A. General requirements:
  - 1. Provide individual checklists and procedures for each system or component.
  - 2. Develop individual checklists and procedures for each tagged piece of equipment. General procedures developed for multiple pieces of equipment, including similar equipment, are not acceptable.
  - 3. Procedures and checklists for specified phases of commissioning (e.g. Pre-startup, startup, functional performance testing) must be submitted and approved prior to commencement of the related activity.
- B. CxA submittals:
  - 1. Commissioning plan.
  - 2. Pre-functional checklists: For each system or component.
  - 3. Startup procedures: For each system or component.
  - 4. Startup checklists: For each system or component.
  - 5. Completed startup checklists: For each system or component.
  - 6. Functional Test Procedures: For each system or component.
  - 7. Functional Test Checklists: For each system or component.
  - 8. Formal acceptance recommendation for each component or system tested, following successful completion of testing.
- C. Contractor submittals:
  - 1. Completed pre-functional checklists: For each system or component.
  - 2. Completed startup checklists: For each system or component.
  - 3. Completed functional test checklists: For each system or component.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. CxA submittals:
  - 1. Qualifications: For CxA and testing technicians.
  - 2. Test equipment calibration certificates.
  - 3. Preliminary Commissioning Report, including the following:

- a. Compiled test results.
  - b. Updated Issues Log.
  - c. Updated Checklist log.
4. Final Commissioning Report, including the following:
- a. Compiled test results.
  - b. Seasonal test results.
  - c. Warranty walkthrough results.
  - d. Completed issues log.
  - e. Completed checklist log.

### **1.06 COMMISSIONING TEAM**

- A. Members Appointed by Contractor(s):
1. Contractor shall appoint a CxC.
  2. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by DEN Project Manager:
1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. DEN will engage the CxA under a separate contract.
  2. Representatives of DEN Sustainability, DEN Project Manager Representative, and DEN Maintenance personnel.
  3. Architect and engineering design professionals.

### **1.07 DEN'S RESPONSIBILITIES**

- A. Assign DEN Sustainability and Operations Maintenance personnel and schedule them to participate in commissioning team activities.
- B. Coordinate activities specified in paragraph below with DOR and Architect-Consultant agreements.
- C. Provide the BoD documentation, prepared by DOR, and approved by DEN, to the CxA and [each ]Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

### **1.08 CONTRACTOR'S RESPONSIBILITIES**

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Include Commissioning requirements in price and plan for work.
  2. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
  3. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
  4. Attend commissioning team meetings held on a weekly basis and progressing to weekly meetings as construction project nears completion.

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5. Integrate and coordinate commissioning process activities with construction schedule.
  6. Review and accept construction pre-functional checklists provided by the CxA prior to commencing functional testing.
  7. Complete electronic construction checklists as Work is completed and provide to the DEN Project Manager after each checklist has been completed.
  8. Review and accept commissioning process functional test procedures provided by the Commissioning Authority.
  9. Designate a CxC from each major subcontractor with activities related to commissioning. These CxCs are to be the primary contacts for Commissioning activities.
  10. Contractor shall incorporate the Commissioning process into the construction schedule, outlining generic Commissioning tasks with precedents or prerequisites to each task. These tasks will apply to many systems and the Contractor shall incorporate as such. Examples of enumerated tasks include, but are not limited to:
    - a. Contractor preparation of the Training Plan
    - b. Testing Agency activities
    - c. Contractor documentation of pipe pressure testing, flushing, and cleaning of applicable systems
    - d. Documentation of the Start-Up Procedures for equipment and systems
    - e. TAB of applicable system
    - f. Preparation of the O&M Manual content
    - g. FPT and Acceptance
    - h. Observation Period and System Optimization
    - i. Occupant or other Regulatory Agency testing or approval process
  11. Assist the CxA in preparation for the specific FPT procedures. Contractors, subcontractors, and vendors shall review the FPTs to ensure feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures that is the result of malfunctioning equipment or contract deficiencies, shall be the responsibility of the Contractor.
  12. Record start-up and testing procedures.
  13. Demonstrate the operation of all systems as specified.
    - a. Operate systems, with assistance of DEN Maintenance, under direction of the CxA during FPT's and other acceptance testing.
- B. Acceptance Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.
1. Work in conjunction with CxA in FPT and shall include, but not limited to the following:
    - a. Operate and Manipulate systems and equipment to facilitate testing (as dictated in this section, relevant technical sections and the Commissioning Plan).
    - b. Operate and Manipulate EMCS and other control systems to facilitate FPT (as dictated in this section, relevant technical sections and the Commissioning Plan).
  2. Correct any work not in accordance with Contract Documents.
  3. Maintain record documentation and update and resubmit it after Functional Completion.
  4. Compensate DEN for additional CxA fees and expenses incurred to retest equipment and systems following testing failures.

5. Monitor systems, equipment, and areas throughout the Transition Period. Log and diagnose all alarms during this period. Maintain trends and logs of all critical parameters. Forward the logs and trends on a weekly basis throughout all Transition Periods.
- C. Warranty Period: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Warranty Period.
1. Provide warranty service
  2. Conduct EMCS Sequence Training
  3. Respond to and document Warranty issues
  4. Correct any deficiencies identified throughout the Warranty Period
  5. Update record documentation to reflect any changes made throughout the Warranty Period and resubmit final Record Drawings and data records at the close of the Warranty period

### **1.09 CXA'S RESPONSIBILITIES**

- A. Organize and lead the commissioning team through the entire project.
- B. Provide and update construction phase commissioning plans.
- C. Convene commissioning team meetings to discuss commissioning activities and current issues and resolutions.
- D. Provide Project-specific construction checklists and commissioning process test procedures.
- E. Review all pertinent equipment submittals, shop drawings, and O&M documentation.
- F. Verify the execution of commissioning process activities. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the DPR. When a requirement is not met, the CxA will report the failure in the Issues Log.
- G. Prepare and maintain the Issues Log.
- H. Prepare and maintain completed construction checklist log.
- I. Organize and lead the functional, seasonal, any LEED required tests, and 10-month Warranty review in the presence of the contractor, DEN Maintenance, and DEN PM assigned personnel.
- J. Witness systems, assemblies, equipment, and component startup.
- K. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

### **1.10 ISSUES LOG**

- A. CxA shall maintain an Issues Log (required information, identified deficiencies, work required, etc.) that relates to Commissioning. Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.

- B. CxA will provide this list to the DEN Project Manager during regular project meetings as appropriate to keep all parties informed.
- C. All parties indicated as responsible for an action item shall respond to the DEN Project Manager. Responses are due within 10 days of action items being identified to the team.

### **1.11 PRE-START UP**

#### **A. PREREQUISITES**

- 1. All equipment, components, and devices applicable to the Pre-Start Up must be installed, and the Pre-Start Up must be documented and approved. This includes installation, identification labeling, insulation, and all other requirements for placing systems into dynamic operation.

#### **B. COMMON ELEMENTS**

- 1. Required submittal documentation shall be present and located convenient to testing area.
- 2. Contractor shall submit the completed Pre-Start Up Procedures at least 10 days prior to the start of Functional testing. CxA shall review the Pre-Start Up Procedure documentation at the beginning of Start Up. Contractor shall demonstrate to DEN Project Manager, DEN Maintenance and DEN Sustainability that access is sufficient to perform required maintenance.
- 3. System and equipment configurations shall be compared against the contract documents.

### **1.12 INSTRUMENTATION**

- A. All test instruments described in this section shall be acceptable for any portion of the commissioning process herein described.
- B. All instruments shall conform to the standards specified in the most recent edition of “NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems” regarding accuracy and calibration status. Current calibration certificates must be available to the CxA if requested.
- C. Test instrument accuracy and resolution must match or exceed that of the system component being verified or calibrated.
- D. Test instruments must be used within guidelines as recommended by instrument manufacturer. All measuring methods must be appropriate to the instrument application and measurements must be repeatable under equivalent conditions.
- E. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis shall be provided by testing entity. These include, but are not limited to:
  - 1. Electronic Manometer (for Air and Flow Hood)
  - 2. Electronic Manometer (for Water)
  - 3. Temperature Instruments
  - 4. Pressure instruments
  - 5. Humidity Instruments
  - 6. CO2 Instrument

7. Sound Meter
8. Electronic Multimeter
9. Tachometer
10. Ultrasonic Flow Meter
11. Others as required

### **1.13 START-UP**

#### **A. Prerequisites**

1. All equipment, components, and devices applicable to the FPT must be started, and the Start-Up must be documented and approved. This includes completion of Start-Up Procedures, pressure testing (of equipment, duct and piping), flushing/cleaning, identification labeling, insulation, and all other requirements for placing systems into dynamic operation.
2. Unless specifically agreed to by DEN and CxA, all support systems shall be complete prior to FPT.
3. The CxA shall determine the optimal sequence of testing.

#### **B. Common Elements**

1. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and [complete] per the contract requirements.
2. Contractor shall provide the completed Start-Up Procedures at the time of testing. CxA shall review the Start-Up Procedure documentation and spot-check at the beginning of FPT.

#### **C. Procedure**

1. Purpose:
  - a. Verify adherence to, and documentation of, quality control processes involved with preparing systems and equipment for operation.
  - b. These procedures shall be performed on all installed systems and equipment and no sampling strategy is used for the start-up process.
  - c. The Commissioning process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment.
  - d. After the procedures are established, the Contractor performs them and documents them with the Start-up Procedures that are developed by the Contractor.
2. Start-Up Procedures: The content of these Start-Up Procedures shall provide the minimally acceptable content in accordance with the OEM field quality control requirements. Generic refers to the fact that the protocols may be created before the shop drawings are finalized. These procedures and protocols will normally be common across different manufacturers.
3. Content of Start-Up Procedures: Start-Up Procedures shall generally include the following for each item of equipment or system (as applicable):
  - a. Project-specific designation, location, and service.
  - b. Indication of the Party performing and documenting the Start-Up Procedure.
  - c. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail indication and a record of measure parameters.
  - d. A Start-up Checklist item indicating that proper maintenance clearances have

been maintained.

4. Recording and Documentation of Factory Start-Up: Manufacturer's start-up protocols shall be executed and forms shall be completed by a qualified/authorized technician.
5. Recording and Documentation of non-Factory Start-Up: The start-up tests and checklists shall be completed by a qualified technician.
6. Commissioning Authority Review: CxA will review and spot-check procedures during FPT.
7. Documentation Completion: The individual executing the start-up must complete the start-up and pre-functional documentation for any given equipment and acknowledge acceptability with the indication of who did the associated task.
8. Sampling and Final Submission: All (100% of) systems are started and documented per the approved procedures and NO sampling strategy is used. Completed Start-up and pre-functional checklists for all pieces of equipment associated with independent systems shall be submitted to CxA prior to any associated FPT. Any outstanding item shall be clearly indicated and an associated Action Item must be entered to track resolution.
9. DEN Access: Contractor shall allow access by DEN representatives to inspect the equipment and ensure its proper operation.

#### **1.14 TEST, ADJUST, AND BALANCE**

- A. CxA shall review TAB reports.
- B. The CxA shall select up to 10% of the readings from the Balancing Reports and verify performance readings. Readings selected by the CxA may include:
  1. Supply air diffuser readings (both minimum and maximum readings for variable air volume boxes).
  2. Main and branch supply duct traverse readings.
  3. Outside/return air flow readings.
  4. Exhaust airflow readings.
  5. Water flow readings.
  6. Ampere readings.
  7. Water pressure drop readings through coils, heat exchangers, and other hydronic elements.
- C. For all readings, a deviation of more than 10% between the verification reading and reported data shall be considered as failing the FPT. The maximum failure rate for the sample is 10%.
- D. If greater than 10% of sample readings have failed, the TAB contractor shall justify all noted failures or rebalance and re-document the system.

#### **1.15 FUNCTIONAL PERFORMANCE TESTING**

- A. Objectives and Scope
  1. Demonstrate that each system is operating according to the documented design intent and Contract Documents.
  2. Bring all commissioned systems from a state of substantial completion to full dynamic operation.

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3. Identify and correct performance deficiencies.
  4. Operate each system through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, normal and emergency power, fire alarm, part- and full-load) where there is a specified system response.
  5. Verify each sequence in the sequences of operation as required.
  6. Verify responses to abnormal operational modes and conditions, such as power failure, freeze conditions, no flow, equipment failure, etc.
- B. Development of Test Procedures
1. CxA shall develop specific test procedures to verify and document proper operation of each piece of equipment and system.
  2. CxA shall develop fill-in forms for use during FPT, based on the test procedures.
  3. Not less than 14 days prior to execution of FPT, CxA shall submit completed test procedures to the DEN Project Manager to review the tests for feasibility, safety, equipment and warranty protection, and scope.
  4. EMCS trends shall have been established as required in the documents. These shall generally be reviewed prior to or during FPT.
  5. Capacities and adjusted/balanced conditions as applicable shall be subject to review.
  6. Sequencing Verification: For applicable systems and equipment, all modes of operation shall be verified for proper sequencing.
  7. System and equipment configurations shall be compared against the contract documents.
  8. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe, and stable operation.
- C. Scheduling:
1. Contractor shall notify the CxA and the DEN Project Manager that systems are ready for testing, to schedule FPT.
  2. To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.
- D. Phasing:
1. Non-interdependent segments of the project testing may be phased.
  2. Phasing of FPT for this project shall be coordinated between the CxA, Contractor, and the DEN Project Manager as the project progresses.
- E. Participation:
1. CxA shall witness and document FPTs performed by the contractor after Start-Up Procedure documentation of systems and equipment has been reviewed and accepted.
  2. Contractor shall perform the FPTs as described, with manipulation of the systems or equipment, provision of supporting equipment or materials (lifts, ladders, specialty test equipment, safety equipment), and on-the-spot remediation of minor identified deficiencies whenever possible.
  3. Required participating Parties shall be indicated in the test plan for each individual FPT.

4. Required participating parties shall be available on-site throughout the testing of any given system for which they are required participants.
  5. CxA shall coordinate effectively with the individual Contractors throughout FPT and minimize their required involvement.
- F. Completeness:
1. All systems must be completed and ready for FPT at the time of the test.
  2. All start up, factory authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and operational for the respective system or component.
- G. Test Documentation:
1. CxA shall witness and document the tests.
  2. CxA shall record all test results on the forms developed for the testing.
  3. CxA shall 'Pass' or 'Fail' the testing and record the date and time of the test.
  4. Deficiencies shall be clearly indicated when the test is failed.
  5. When all related testing is completed successfully, CxA shall recommend acceptance of the system or component.
  6. In the case of specialized testing, CxA shall witness and review the testing reports prepared by the Contractor.
- H. Acceptance Criteria
1. The Acceptance Criteria shall be as follows unless specifically indicated within applicable individual specification sections or test procedures.
    - a. Accuracy/repeatability on sensing devices will be as specified for the device. CxA and TAB will use calibrated gauges for independent validation of sensing devices.
    - b. HVAC sequence-related criteria will be as specified in the documents.
- I. Deficiencies
1. CxA shall record the results of each functional test. All deficiencies or non-conformance issues shall be brought to Contractor's attention immediately, noted in the Issues Log, and reported to the DEN Project Manager within 72 hours.
    - a. Corrections of identified minor deficiencies may be made during the tests where feasible. In such cases, the deficiency will be noted on the FPT documents.
    - b. Deficiencies with potential schedule or cost impacts shall be reported to the DEN Project Manager within 24 hours of discovery.
  2. Contractor shall correct all identified deficiencies as directed by the DEN Project Manager.
    - a. CxA shall maintain Contractor's response to each deficiency in the Issues Log.
    - b. Contractor shall correct each deficiency, and notify CxA upon completion by completing an action item response.
    - c. Contractor shall schedule repeat testing and ensure CxA is available to observe.
  3. Disputes:
    - a. Contractor shall notify the DEN Project Manager and CxA immediately if the responsibility or nature of any identified deficiency is in dispute.
    - b. The CxA shall document as a disputed deficiency in the Issues Log.
    - c. The Contractor shall negotiate a resolution to the dispute with the DEN Project

- Manager.
- d. Upon resolution, CxA shall update the Issues Log to reflect the status of the deficiency
- J. Sampling Percentage:
1. Sampling percentage shall be as indicated in the test plan.
  2. Where no sampling percentage is indicated, the implied sampling percentage is 100% and all units shall be tested.
- K. Maximum Failure Limit:
1. Maximum Failure Limit shall be as indicated in the test plan.
  2. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.
  3. If no Maximum Failure Limit is indicated, the implied failure limit is 0% and all tested samples must pass.
  4. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems), the Maximum Failure Limit will apply per system.
  5. The responsible Contractors shall reimburse DEN for the CxA's cost of that sample test, and redo the start-up and TAB for the applicable devices/systems.
  6. All work necessitated by sample failures shall be at no cost to DEN.
- L. Manufacturer's Defects:
1. If 10% of identical pieces of equipment fail to perform to the Contract Documents (mechanically or substantively) due to a manufacturing defect, all identical units may be considered unacceptable by the DEN Project Manager.
  2. For the purposes of defining 'identical equipment' for this Section, size or capacity alone does not constitute a difference.
  3. In case of failure due to manufacturer's defects, the Contractor shall provide DEN with the following:
    - a. Manufacturer's response in writing as to the cause of the failure and proposed resolution.
    - b. Manufacturer shall implement their proposed resolution on a representative sample of the product.
    - c. The DEN Project Manager will determine whether a replacement of all identical units or a repair is acceptable.
    - d. Upon acceptance, the Contractor shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
    - e. Manufacturer shall pay the costs of all retesting necessitated by the failure.

## **1.16 CLOSEOUT**

- A. Commissioning Report
1. A final summary report by the CxA shall be provided to the DEN Project Manager, focusing on evaluating commissioning process issues and identifying areas where the process could be improved.
  2. Include all acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., compiled in appendices, and provided with the summary report.

3. Pre-Start Up verification, Start Up checklists, TAB, functional tests, and monitoring reports shall not be included in the final report, but shall be submitted as part of the Commissioning Record in the O&M manuals.
- B. Logs
1. CxA shall submit an updated Issues Log and all Issues Logs upon substantial completion of the project.
- C. Acceptance
1. CxA shall recommend acceptance of each test in writing to the DEN Project Manager.
  2. The CxA shall note each satisfactorily demonstrated function on the test documentation.
  3. Tests shall be considered accepted only upon formal acceptance by the DEN Project Manager.
- D. Training
1. The Contractor shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
  2. The CxA shall witness the content and adequacy of the training of DEN personnel for commissioned equipment. Any issues shall be noted in the Issues Log and reported immediately to the DEN Project Manager.
- E. Operation and Maintenance Manual and Record Drawing Review
1. Prior to substantial completion, the CxA shall review the O&M manuals, documentation, and redlined as-built drawings for systems that were commissioned to verify compliance with the Specifications.
  2. The CxA shall review completed record drawings and document any discrepancies in the Issues Log.

## **1.17 WARRANTY PERIOD**

- A. Warranty Walkthrough
1. General Requirements
    - a. Contractor and CxA, as directed by the DEN Project Manager, shall participate in an on-site walkthrough to review the condition of the project prior to expiration of the Contractor's warranty (the "warranty walkthrough").
    - b. The warranty walkthrough shall occur not less than nine (9) months following substantial completion, and not more than eleven (11) months following substantial completion.
    - c. Any deficiencies identified during the warranty walkthrough shall be identified and tracked using the Issues Log, and shall be provided in writing to the DEN Project Manager.
  2. Required Attendees:
    - a. Installing Contractor, and subcontractor representatives.
    - b. TAB Contractor.
    - c. CxA.
    - d. DEN Project Manager, or authorized representative.
    - e. DEN Asset Manager, or authorized representative.
  3. Contractor's Responsibilities

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 019113 – COMMISSIONING REQUIREMENTS**

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- a. Contractor shall provide personnel at the warranty walkthrough as necessary to facilitate operation of equipment and testing procedures. Confirm with the DEN Project Manager a full list of attendees with their contact information not less than (4) weeks prior to scheduled warranty walkthrough. Required attendees shall include:
    - 1) Contractor's Project Manager.
    - 2) Manufacturer's representative(s) for commissioned equipment.
    - 3) Electrical Subcontractor.
    - 4) Mechanical Subcontractor.
    - 5) Others, as required by the DEN project Manager.
  - b. Contractor, or designated subcontractor or manufacturer's representative under direction of Contractor, shall operate equipment during the warranty walkthrough as directed by the DEN Project Manager.
4. CxA's Responsibilities
- a. CxA, under direction from the DEN Project Manager and DEN Asset Management, shall facilitate the inspection and verification of all commissioned systems as part of the on-site warranty walkthrough.
  - b. CxA shall perform visual inspection of equipment to document any warranty-related defects or damage.
  - c. CxA shall perform basic functional verification of equipment to affirm the equipment is operating in compliance with Contract Documents.
  - d. The CxA shall document any deficiencies found during the warranty walkthrough in the Issues Log and notify the DEN Project Manager.
  - e. Required documentation:
    - 1) Not less than (4) weeks prior to the scheduled warranty walkthrough, submit a warranty inspection checklist, including:
      - a) A section for each individual piece of equipment.
      - b) Expected attendees and responsibilities.
      - c) Fields or checkboxes for each individual inspection procedure or measurement as directed by the DEN Project Manager.
    - 2) CxA shall provide the approved warranty inspection checklist for use on-site at the warranty walkthrough.
    - 3) CxA shall provide the current Issues Log for use on-site at the warranty walkthrough.
    - 4) CxA shall provide an updated Issues Log to the DEN Project Manager following completion of the warranty walkthrough.
- B. Seasonal Testing
1. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract.
  2. The CxA shall coordinate this activity with the DEN Project Manager and the Contractor.
  3. Tests will be executed, documented and deficiencies corrected by the appropriate parties, with DEN maintenance staff and the CxA witnessing.
  4. Any final adjustments to the O&M manuals and Record Drawings due to the testing will be made by the responsible parties.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 019113**

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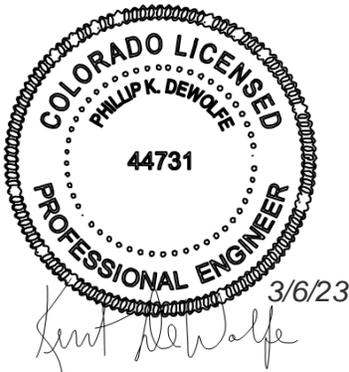
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FAA General Provisions  
& FAA Tech Specs (Civil)



MEP CSI Specs



Electrical Specs



# PROJECT MANUAL

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## VOLUME II

TECHNICAL SPECIFICATIONS

ISSUED FOR CONSTRUCTION

MARCH 06, 2023

CITY & COUNTY OF DENVER

DEPARTMENT OF AVIATION

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**END OF SECTION**

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### Section 10 Definition of Terms

When the following terms are used in these specifications, in the contract, or in any documents or other instruments pertaining to construction where these specifications govern, the intent and meaning shall be defined as follows:

Paragraph Number	Term	Definition
10-01	<b>AASHTO</b>	The American Association of State Highway and Transportation Officials.
10-02	<b>Access Road</b>	The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public roadway.
10-03	<b>Advertisement</b>	A public announcement, as required by local law, inviting bids for work to be performed and materials to be furnished.
10-04	<b>Airport</b>	Airport means an area of land or water which is used or intended to be used for the landing and takeoff of aircraft; an appurtenant area used or intended to be used for airport buildings or other airport facilities or rights of way; airport buildings and facilities located in any of these areas, and a heliport.
10-05	<b>Airport Improvement Program (AIP)</b>	A grant-in-aid program, administered by the Federal Aviation Administration (FAA).
10-06	<b>Air Operations Area (AOA)</b>	The term air operations area (AOA) shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operation area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.
10-07	<b>Apron</b>	Area where aircraft are parked, unloaded or loaded, fueled and/or serviced.
10-08	<b>ASTM International (ASTM)</b>	Formerly known as the American Society for Testing and Materials (ASTM).

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<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
<b>10-09</b>	<b>Award</b>	The Owner's notice to the successful bidder of the acceptance of the submitted bid.
<b>10-10</b>	<b>Bidder</b>	Any individual, partnership, firm, or corporation, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated.
<b>10-11</b>	<b>Building Area</b>	An area on the airport to be used, considered, or intended to be used for airport buildings or other airport facilities or rights-of-way together with all airport buildings and facilities located thereon.
<b>10-12</b>	<b>Calendar Day</b>	Every day shown on the calendar.
<b>10-13</b>	<b>Certificate of Analysis (COA)</b>	The COA is the manufacturer's Certificate of Compliance (COC) including all applicable test results required by the specifications.
<b>10-14</b>	<b>Certificate of Compliance (COC)</b>	The manufacturer's certification stating that materials or assemblies furnished fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer's authorized representative.
<b>10-15</b>	<b>Change Order</b>	A written order to the Contractor covering changes in the plans, specifications, or proposal quantities and establishing the basis of payment and contract time adjustment, if any, for work within the scope of the contract and necessary to complete the project.
<b>10-16</b>	<b>Contract</b>	<p>A written agreement between the Owner and the Contractor that establishes the obligations of the parties including but not limited to performance of work, furnishing of labor, equipment and materials and the basis of payment.</p> <p>The awarded contract includes but may not be limited to: Advertisement, Contract form, Proposal, Performance bond, payment bond, General provisions, certifications and representations, Technical Specifications, Plans, Supplemental Provisions, standards incorporated by reference and issued addenda.</p>
<b>10-17</b>	<b>Contract Item (Pay Item)</b>	A specific unit of work for which a price is provided in the contract.

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Paragraph Number	Term	Definition
10-18	<b>Contract Time</b>	The number of calendar days or working days, stated in the proposal, allowed for completion of the contract, including authorized time extensions. If a calendar date of completion is stated in the proposal, in lieu of a number of calendar or working days, the contract shall be completed by that date.
10-19	<b>Contractor</b>	The individual, partnership, firm, or corporation primarily liable for the acceptable performance of the work contracted and for the payment of all legal debts pertaining to the work who acts directly or through lawful agents or employees to complete the contract work.
10-20	<b>Contractors Quality Control (QC) Facilities</b>	The Contractor's QC facilities in accordance with the Contractor Quality Control Program (CQCP).
10-21	<b>Contractor Quality Control Program (CQCP)</b>	Details the methods and procedures that will be taken to assure that all materials and completed construction required by the contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors.
10-22	<b>Control Strip</b>	A demonstration by the Contractor that the materials, equipment, and construction processes results in a product meeting the requirements of the specification.
10-23	<b>Construction Safety and Phasing Plan (CSPP)</b>	The overall plan for safety and phasing of a construction project developed by the airport operator, or developed by the airport operator's consultant and approved by the airport operator. It is included in the invitation for bids and becomes part of the project specifications.
10-24	<b>Drainage System</b>	The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the airport area.
10-25	<b>Engineer</b>	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for engineering, inspection, and/or observation of the contract work and acting directly or through an authorized representative.

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Paragraph Number	Term	Definition
10-26	Equipment	All machinery, together with the necessary supplies for upkeep and maintenance; and all tools and apparatus necessary for the proper construction and acceptable completion of the work.
10-27	Extra Work	An item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, but which is found by the Owner's Engineer or Resident Project Representative (DEN PM) to be necessary to complete the work within the intended scope of the contract as previously modified.
10-28	FAA	The Federal Aviation Administration. When used to designate a person, FAA shall mean the Administrator or their duly authorized representative.
10-29	Federal Specifications	The federal specifications and standards, commercial item descriptions, and supplements, amendments, and indices prepared and issued by the General Services Administration.
10-30	Force Account	<p><b>a.</b> Contract Force Account - A method of payment that addresses extra work performed by the Contractor on a time and material basis.</p> <p><b>b.</b> Owner Force Account - Work performed for the project by the Owner's employees.</p>
10-31	Intention of Terms	<p>Whenever, in these specifications or on the plans, the words "directed," "required," "permitted," "ordered," "designated," "prescribed," or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer and/or Resident Project Representative (DEN PM) is intended; and similarly, the words "approved," "acceptable," "satisfactory," or words of like import, shall mean approved by, or acceptable to, or satisfactory to the Engineer and/or DEN PM, subject in each case to the final determination of the Owner.</p> <p>Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard shall be interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference.</p>

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Paragraph Number	Term	Definition
10-32	<b>Lighting</b>	A system of fixtures providing or controlling the light sources used on or near the airport or within the airport buildings. The field lighting includes all luminous signals, markers, floodlights, and illuminating devices used on or near the airport or to aid in the operation of aircraft landing at, taking off from, or taxiing on the airport surface.
10-33	<b>Major and Minor Contract Items</b>	A major contract item shall be any item that is listed in the proposal, the total cost of which is equal to or greater than 20% of the total amount of the award contract. All other items shall be considered minor contract items.
10-34	<b>Materials</b>	Any substance specified for use in the construction of the contract work.
10-35	<b>Modification of Standards (MOS)</b>	Any deviation from standard specifications applicable to material and construction methods in accordance with FAA Order 5300.1.
10-36	<b>Notice to Proceed (NTP)</b>	A written notice to the Contractor to begin the actual contract work on a previously agreed to date. If applicable, the Notice to Proceed shall state the date on which the contract time begins.
10-37	<b>Owner</b>	The term "Owner" shall mean the party of the first part or the contracting agency signatory to the contract. Where the term "Owner" is capitalized in this document, it shall mean airport Sponsor only. The Owner for this project is <u>the city and county of Denver</u> .
10-38	<b>Passenger Facility Charge (PFC)</b>	Per 14 Code of Federal Regulations (CFR) Part 158 and 49 United States Code (USC) § 40117, a PFC is a charge imposed by a public agency on passengers enplaned at a commercial service airport it controls.
10-39	<b>Pavement Structure</b>	The combined surface course, base course(s), and subbase course(s), if any, considered as a single unit.
10-40	<b>Payment bond</b>	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will pay in full all bills and accounts for materials and labor used in the construction of the work.

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<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
<b>10-41</b>	<b>Performance bond</b>	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will complete the work in accordance with the terms of the contract.
<b>10-42</b>	<b>Plans</b>	The official drawings or exact reproductions which show the location, character, dimensions and details of the airport and the work to be done and which are to be considered as a part of the contract, supplementary to the specifications. Plans may also be referred to as 'contract drawings.'
<b>10-43</b>	<b>Project</b>	The agreed scope of work for accomplishing specific airport development with respect to a particular airport.
<b>10-44</b>	<b>Proposal</b>	The written offer of the bidder (when submitted on the approved proposal form) to perform the contemplated work and furnish the necessary materials in accordance with the provisions of the plans and specifications.
<b>10-45</b>	<b>Proposal guaranty</b>	The security furnished with a proposal to guarantee that the bidder will enter into a contract if their own proposal is accepted by the Owner.
<b>10-46</b>	<b>Quality Assurance (QA)</b>	Owner's responsibility to assure that construction work completed complies with specifications for payment.
<b>10-47</b>	<b>Quality Control (QC)</b>	Contractor's responsibility to control material(s) and construction processes to complete construction in accordance with project specifications.
<b>10-48</b>	<b>Quality Assurance (QA) Inspector</b>	An authorized representative of the Engineer and/or Resident Project Representative (DEN PM) assigned to make all necessary inspections, observations, tests, and/or observation of tests of the work performed or being performed, or of the materials furnished or being furnished by the Contractor.
<b>10-49</b>	<b>Quality Assurance (QA) Laboratory</b>	The official quality assurance testing laboratories of the Owner or such other laboratories as may be designated by the Engineer or DEN PM. May also be referred to as Engineer's, Owner's, or QA Laboratory.

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Paragraph Number	Term	Definition
10-50	<b>DEN Project Manager (DEN PM)</b>	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for all necessary inspections, observations, tests, and/or observations of tests of the contract work performed or being performed, or of the materials furnished or being furnished by the Contractor, and acting directly or through an authorized representative.
10-51	<b>Runway</b>	The area on the airport prepared for the landing and takeoff of aircraft.
10-52	<b>Runway Safety Area (RSA)</b>	A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to aircraft. See the construction safety and phasing plan (CSPP) for limits of the RSA.
10-53	<b>Safety Plan Compliance Document (SPCD)</b>	Details how the Contractor will comply with the CSPP.
10-54	<b>Specifications</b>	A part of the contract containing the written directions and requirements for completing the contract work. Standards for specifying materials or testing which are cited in the contract specifications by reference shall have the same force and effect as if included in the contract physically.
10-55	<b>Sponsor</b>	A Sponsor is defined in 49 USC § 47102(24) as a public agency that submits to the FAA for an AIP grant; or a private Owner of a public-use airport that submits to the FAA an application for an AIP grant for the airport.
10-56	<b>Structures</b>	Airport facilities such as bridges; culverts; catch basins, inlets, retaining walls, cribbing; storm and sanitary sewer lines; water lines; underdrains; electrical ducts, manholes, handholes, lighting fixtures and bases; transformers; navigational aids; buildings; vaults; and, other manmade features of the airport that may be encountered in the work and not otherwise classified herein.
10-57	<b>Subgrade</b>	The soil that forms the pavement foundation.
10-58	<b>Superintendent</b>	The Contractor's executive representative who is present on the work during progress, authorized to

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Paragraph Number	Term	Definition
		receive and fulfill instructions from the DEN PM, and who shall supervise and direct the construction.
10-59	<b>Supplemental Agreement</b>	A written agreement between the Contractor and the Owner that establishes the basis of payment and contract time adjustment, if any, for the work affected by the supplemental agreement. A supplemental agreement is required if: (1) in scope work would increase or decrease the total amount of the awarded contract by more than 25%; (2) in scope work would increase or decrease the total of any major contract item by more than 25%; (3) work that is not within the scope of the originally awarded contract; or (4) adding or deleting of a major contract item.
10-60	<b>Surety</b>	The corporation, partnership, or individual, other than the Contractor, executing payment or performance bonds that are furnished to the Owner by the Contractor.
10-61	<b>Taxilane</b>	A taxiway designed for low speed movement of aircraft between aircraft parking areas and terminal areas.
10-62	<b>Taxiway</b>	The portion of the air operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways, aircraft parking areas, and terminal areas.
10-63	<b>Taxiway/Taxilane Safety Area (TSA)</b>	A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an aircraft. See the construction safety and phasing plan (CSPP) for limits of the TSA.
10-64	<b>Work</b>	The furnishing of all labor, materials, tools, equipment, and incidentals necessary or convenient to the Contractor's performance of all duties and obligations imposed by the contract, plans, and specifications.
10-65	<b>Working day</b>	A working day shall be any day other than a legal holiday, Saturday, or Sunday on which the normal working forces of the Contractor may proceed with regular work for at least six (6) hours toward completion of the contract. When work is suspended for causes beyond the Contractor's control, it will not be counted as a working day. Saturdays, Sundays

<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
		and holidays on which the Contractor's forces engage in regular work will be considered as working days.
<b>10-66</b>	<b>Owner Defined terms</b>	None

**END OF SECTION 10**

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## Section 20 Proposal Requirements and Conditions

**20-01 Advertisement (Notice to Bidders).** This project has been advertised on the DEN Contract Procurement Website. <http://business.flydenver.com/bizops/bids.asp>.

**20-02 Qualification of bidders.** Each bidder shall submit evidence of competency and evidence of financial responsibility to perform the work to the Owner at the time of bid opening.

Evidence of competency, unless otherwise specified, shall consist of statements covering the bidder's past experience on similar work, and a list of equipment and a list of key personnel that would be available for the work.

Each bidder shall furnish the Owner satisfactory evidence of their financial responsibility. Evidence of financial responsibility, unless otherwise specified, shall consist of a confidential statement or report of the bidder's financial resources and liabilities as of the last calendar year or the bidder's last fiscal year. Such statements or reports shall be certified by a public accountant. At the time of submitting such financial statements or reports, the bidder shall further certify whether their financial responsibility is approximately the same as stated or reported by the public accountant. If the bidder's financial responsibility has changed, the bidder shall qualify the public accountant's statement or report to reflect the bidder's true financial condition at the time such qualified statement or report is submitted to the Owner.

Unless otherwise specified, a bidder may submit evidence that they are prequalified with the State Highway Division and are on the current "bidder's list" of the state in which the proposed work is located. Evidence of State Highway Division prequalification may be submitted as evidence of financial responsibility in lieu of the certified statements or reports specified above.

**20-03 Contents of proposal forms.** The Owner's proposal forms state the location and description of the proposed construction; the place, date, and time of opening of the proposals; and the estimated quantities of the various items of work to be performed and materials to be furnished for which unit bid prices are asked. The proposal form states the time in which the work must be completed, and the amount of the proposal guaranty that must accompany the proposal. The Owner will accept only those Proposals properly executed on physical forms or electronic forms provided by the Owner. Bidder actions that may cause the Owner to deem a proposal irregular are given in paragraph 20-09 *Irregular proposals*.

Mobilization is limited to 10 percent of the total project cost.

A prebid conference is required on this project to discuss as a minimum, the following items: material requirements; submittals; Quality Control/Quality Assurance requirements; the construction safety and phasing plan including airport access and staging areas; and unique airfield paving construction requirements. See project advertisement for prebid information.

**20-04 Issuance of proposal forms.** The Owner reserves the right to refuse to issue a proposal form to a prospective bidder if the bidder is in default for any of the following reasons:

a. Failure to comply with any prequalification regulations of the Owner, if such regulations are cited, or otherwise included, in the proposal as a requirement for bidding.

**b.** Failure to pay, or satisfactorily settle, all bills due for labor and materials on former contracts in force with the Owner at the time the Owner issues the proposal to a prospective bidder.

**c.** Documented record of Contractor default under previous contracts with the Owner.

**d.** Documented record of unsatisfactory work on previous contracts with the Owner.

**20-05 Interpretation of estimated proposal quantities.** An estimate of quantities of work to be done and materials to be furnished under these specifications is given in the proposal. It is the result of careful calculations and is believed to be correct. It is given only as a basis for comparison of proposals and the award of the contract. The Owner does not expressly, or by implication, agree that the actual quantities involved will correspond exactly therewith; nor shall the bidder plead misunderstanding or deception because of such estimates of quantities, or of the character, location, or other conditions pertaining to the work. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications. It is understood that the quantities may be increased or decreased as provided in the Section 40, paragraph 40-02, Alteration of Work and Quantities, without in any way invalidating the unit bid prices.

**20-06 Examination of plans, specifications, and site.** The bidder is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, and contract forms. Bidders shall satisfy themselves to the character, quality, and quantities of work to be performed, materials to be furnished, and to the requirements of the proposed contract. The submission of a proposal shall be prima facie evidence that the bidder has made such examination and is satisfied to the conditions to be encountered in performing the work and the requirements of the proposed contract, plans, and specifications.

Boring logs and other records of subsurface investigations and tests are available for inspection of bidders. It is understood and agreed that such subsurface information, whether included in the plans, specifications, or otherwise made available to the bidder, was obtained and is intended for the Owner's design and estimating purposes only. Such information has been made available for the convenience of all bidders. It is further understood and agreed that each bidder is solely responsible for all assumptions, deductions, or conclusions which the bidder may make or obtain from their own examination of the boring logs and other records of subsurface investigations and tests that are furnished by the Owner.

**20-07 Preparation of proposal.** The bidder shall submit their proposal on the forms furnished by the Owner. All blank spaces in the proposal forms, unless explicitly stated otherwise, must be correctly filled in where indicated for each and every item for which a quantity is given. The bidder shall state the price (written in ink or typed) both in words and numerals which they propose for each pay item furnished in the proposal. In case of conflict between words and numerals, the words, unless obviously incorrect, shall govern.

The bidder shall correctly sign the proposal in ink. If the proposal is made by an individual, their name and post office address must be shown. If made by a partnership, the name and post office address of each member of the partnership must be shown. If made by a corporation, the person signing the proposal shall give the name of the state where the corporation was chartered and the name, titles, and business address of the president, secretary, and the treasurer. Anyone signing a proposal as an agent shall file evidence of their authority to do so and that the signature is binding upon the firm or corporation.

**20-08 Responsive and responsible bidder.** A responsive bid conforms to all significant terms and conditions contained in the Owner's invitation for bid. It is the Owner's responsibility to

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decide if the exceptions taken by a bidder to the solicitation are material or not and the extent of deviation it is willing to accept.

A responsible bidder has the ability to perform successfully under the terms and conditions of a proposed procurement, as defined in 2 CFR § 200.318(h). This includes such matters as Contractor integrity, compliance with public policy, record of past performance, and financial and technical resources.

**20-09 Irregular proposals.** Proposals shall be considered irregular for the following reasons:

- a. If the proposal is on a form other than that furnished by the Owner, or if the Owner's form is altered, or if any part of the proposal form is detached.
- b. If there are unauthorized additions, conditional or alternate pay items, or irregularities of any kind that make the proposal incomplete, indefinite, or otherwise ambiguous.
- c. If the proposal does not contain a unit price for each pay item listed in the proposal, except in the case of authorized alternate pay items, for which the bidder is not required to furnish a unit price.
- d. If the proposal contains unit prices that are obviously unbalanced.
- e. If the proposal is not accompanied by the proposal guaranty specified by the Owner.
- f. If the applicable Disadvantaged Business Enterprise information is incomplete.

The Owner reserves the right to reject any irregular proposal and the right to waive technicalities if such waiver is in the best interest of the Owner and conforms to local laws and ordinances pertaining to the letting of construction contracts.

**20-10 Bid guarantee.** Each separate proposal shall be accompanied by a bid bond, certified check, or other specified acceptable collateral, in the amount specified in the proposal form. Such bond, check, or collateral, shall be made payable to the Owner.

**20-11 Delivery of proposal.** Each proposal submitted shall be placed in a sealed envelope plainly marked with the project number, location of airport, and name and business address of the bidder on the outside. When sent by mail, preferably registered, the sealed proposal, marked as indicated above, should be enclosed in an additional envelope. No proposal will be considered unless received at the place specified in the advertisement or as modified by Addendum before the time specified for opening all bids. Proposals received after the bid opening time shall be returned to the bidder unopened.

**20-12 Withdrawal or revision of proposals.** A bidder may withdraw or revise (by withdrawal of one proposal and submission of another) a proposal provided that the bidder's request for withdrawal is received by the Owner in writing or by email before the time specified for opening bids. Revised proposals must be received at the place specified in the advertisement before the time specified for opening all bids.

**20-13 Public opening of proposals.** Proposals shall be opened, and read, publicly at the time and place specified in the advertisement. Bidders, their authorized agents, and other interested persons are invited to attend. Proposals that have been withdrawn (by written or telegraphic request) or received after the time specified for opening bids shall be returned to the bidder unopened.

**20-14 Disqualification of bidders.** A bidder shall be considered disqualified for any of the following reasons:

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a. Submitting more than one proposal from the same partnership, firm, or corporation under the same or different name.

b. Evidence of collusion among bidders. Bidders participating in such collusion shall be disqualified as bidders for any future work of the Owner until any such participating bidder has been reinstated by the Owner as a qualified bidder.

c. If the bidder is considered to be in “default” for any reason specified in paragraph 20-04, *Issuance of Proposal Forms*, of this section.

**20-15 Discrepancies and Omissions.** A Bidder who discovers discrepancies or omissions with the project bid documents shall immediately notify the Owner’s Engineer of the matter. A bidder that has doubt as to the true meaning of a project requirement may submit to the Owner’s Engineer a written request for interpretation no later than 7 days prior to bid opening.

Any interpretation of the project bid documents by the Owner’s Engineer will be by written addendum issued by the Owner. The Owner will not consider any instructions, clarifications or interpretations of the bidding documents in any manner other than written addendum.

**END OF SECTION 20**

## Section 30 Award and Execution of Contract

**30-01 Consideration of proposals.** After the proposals are publicly opened and read, they will be compared on the basis of the summation of the products obtained by multiplying the estimated quantities shown in the proposal by the unit bid prices. If a bidder's proposal contains a discrepancy between unit bid prices written in words and unit bid prices written in numbers, the unit bid price written in words shall govern.

Until the award of a contract is made, the Owner reserves the right to reject a bidder's proposal for any of the following reasons:

a. If the proposal is irregular as specified in Section 20, paragraph 20-09, *Irregular Proposals*.

b. If the bidder is disqualified for any of the reasons specified Section 20, paragraph 20-14, *Disqualification of Bidders*.

In addition, until the award of a contract is made, the Owner reserves the right to reject any or all proposals, waive technicalities, if such waiver is in the best interest of the Owner and is in conformance with applicable state and local laws or regulations pertaining to the letting of construction contracts; advertise for new proposals; or proceed with the work otherwise. All such actions shall promote the Owner's best interests.

**30-02 Award of contract.** The award of a contract, if it is to be awarded, shall be made within 90 calendar days of the date specified for publicly opening proposals, unless otherwise specified herein.

If the Owner elects to proceed with an award of contract, the Owner will make award to the responsible bidder whose bid, conforming with all the material terms and conditions of the bid documents, is the lowest in price.

**30-03 Cancellation of award.** The Owner reserves the right to cancel the award without liability to the bidder, except return of proposal guaranty, at any time before a contract has been fully executed by all parties and is approved by the Owner in accordance with paragraph 30-07 *Approval of Contract*.

**30-04 Return of proposal guaranty.** All proposal guaranties, except those of the two lowest bidders, will be returned immediately after the Owner has made a comparison of bids as specified in the paragraph 30-01, *Consideration of Proposals*. Proposal guaranties of the two lowest bidders will be retained by the Owner until such time as an award is made, at which time, the unsuccessful bidder's proposal guaranty will be returned. The successful bidder's proposal guaranty will be returned as soon as the Owner receives the contract bonds as specified in paragraph 30-05, *Requirements of Contract Bonds*.

**30-05 Requirements of contract bonds.** At the time of the execution of the contract, the successful bidder shall furnish the Owner a surety bond or bonds that have been fully executed by the bidder and the surety guaranteeing the performance of the work and the payment of all legal debts that may be incurred by reason of the Contractor's performance of the work. The surety and the form of the bond or bonds shall be acceptable to the Owner. Unless otherwise

specified in this subsection, the surety bond or bonds shall be in a sum equal to the full amount of the contract.

**30-06 Execution of contract.** The successful bidder shall sign (execute) the necessary agreements for entering into the contract and return the signed contract to the Owner, along with the fully executed surety bond or bonds specified in paragraph 30-05, *Requirements of Contract Bonds*, of this section, within 15 calendar days from the date mailed or otherwise delivered to the successful bidder.

**30-07 Approval of contract.** Upon receipt of the contract and contract bond or bonds that have been executed by the successful bidder, the Owner shall complete the execution of the contract in accordance with local laws or ordinances, and return the fully executed contract to the Contractor. Delivery of the fully executed contract to the Contractor shall constitute the Owner's approval to be bound by the successful bidder's proposal and the terms of the contract.

**30-08 Failure to execute contract.** Failure of the successful bidder to execute the contract and furnish an acceptable surety bond or bonds within the period specified in paragraph 30-06, *Execution of Contract*, of this section shall be just cause for cancellation of the award and forfeiture of the proposal guaranty, not as a penalty, but as liquidated damages to the Owner.

**END OF SECTION 30**

## Section 40 Scope of Work

**40-01 Intent of contract.** The intent of the contract is to provide for construction and completion, in every detail, of the work described. It is further intended that the Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

**40-02 Alteration of work and quantities.** The Owner reserves the right to make such changes in quantities and work as may be necessary or desirable to complete, in a satisfactory manner, the original intended work. Unless otherwise specified in the Contract, the Owner's Engineer or DEN PM shall be and is hereby authorized to make, in writing, such in-scope alterations in the work and variation of quantities as may be necessary to complete the work, provided such action does not represent a significant change in the character of the work.

For purpose of this section, a significant change in character of work means: any change that is outside the current contract scope of work; any change (increase or decrease) in the total contract cost by more than 25%; or any change in the total cost of a major contract item by more than 25%.

Work alterations and quantity variances that do not meet the definition of significant change in character of work shall not invalidate the contract nor release the surety. Contractor agrees to accept payment for such work alterations and quantity variances in accordance with Section 90, paragraph 90-03, *Compensation for Altered Quantities*.

Should the value of altered work or quantity variance meet the criteria for significant change in character of work, such altered work and quantity variance shall be covered by a supplemental agreement. Supplemental agreements shall also require consent of the Contractor's surety and separate performance and payment bonds. If the Owner and the Contractor are unable to agree on a unit adjustment for any contract item that requires a supplemental agreement, the Owner reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

**40-03 Omitted items.** The Owner, the Owner's Engineer or the DEN PM may provide written notice to the Contractor to omit from the work any contract item that does not meet the definition of major contract item. Major contract items may be omitted by a supplemental agreement. Such omission of contract items shall not invalidate any other contract provision or requirement.

Should a contract item be omitted or otherwise ordered to be non-performed, the Contractor shall be paid for all work performed toward completion of such item prior to the date of the order to omit such item. Payment for work performed shall be in accordance with Section 90, paragraph 90-04, *Payment for Omitted Items*.

**40-04 Extra work.** Should acceptable completion of the contract require the Contractor to perform an item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, Owner may issue a Change Order to cover the necessary extra work. Change orders for extra work shall contain agreed unit prices for performing the change order work in accordance with the requirements specified in the order, and shall contain any adjustment to the contract time that, in the DEN PM's opinion, is necessary for completion of the extra work.

When determined by the DEN PM to be in the Owner's best interest, the DEN PM may order the Contractor to proceed with extra work as provided in Section 90, paragraph 90-05, *Payment for Extra Work*. Extra work that is necessary for acceptable completion of the project, but is not within the general scope of the work covered by the original contract shall be covered by a supplemental agreement as defined in Section 10, paragraph 10-59, *Supplemental Agreement*.

If extra work is essential to maintaining the project critical path, DEN PM may order the Contractor to commence the extra work under a Time and Material contract method. Once sufficient detail is available to establish the level of effort necessary for the extra work, the Owner shall initiate a change order or supplemental agreement to cover the extra work.

Any claim for payment of extra work that is not covered by written agreement (change order or supplemental agreement) shall be rejected by the Owner.

**40-05 Maintenance of traffic.** It is the explicit intention of the contract that the safety of aircraft, as well as the Contractor's equipment and personnel, is the most important consideration. The Contractor shall maintain traffic in the manner detailed in the Construction Safety and Phasing Plan (CSPP).

a. It is understood and agreed that the Contractor shall provide for the free and unobstructed movement of aircraft in the air operations areas (AOAs) of the airport with respect to their own operations and the operations of all subcontractors as specified in Section 80, paragraph 80-04, *Limitation of Operations*. It is further understood and agreed that the Contractor shall provide for the uninterrupted operation of visual and electronic signals (including power supplies thereto) used in the guidance of aircraft while operating to, from, and upon the airport as specified in Section 70, paragraph 70-15, *Contractor's Responsibility for Utility Service and Facilities of Others*.

b. With respect to their own operations and the operations of all subcontractors, the Contractor shall provide marking, lighting, and other acceptable means of identifying personnel, equipment, vehicles, storage areas, and any work area or condition that may be hazardous to the operation of aircraft, fire-rescue equipment, or maintenance vehicles at the airport in accordance with the construction safety and phasing plan (CSPP) and the safety plan compliance document (SPCD).

c. When the contract requires the maintenance of an existing road, street, or highway during the Contractor's performance of work that is otherwise provided for in the contract, plans, and specifications, the Contractor shall keep the road, street, or highway open to all traffic and shall provide maintenance as may be required to accommodate traffic. The Contractor, at their expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel. The Contractor shall furnish, erect, and maintain barricades, warning signs, flag person, and other traffic control devices in reasonable conformity with the Manual on Uniform Traffic Control Devices (MUTCD) (<http://mutcd.fhwa.dot.gov/>), unless otherwise specified. The Contractor shall also construct and maintain in a safe condition any temporary connections necessary for ingress to and egress from abutting property or intersecting roads, streets or highways.

**40-06 Removal of existing structures.** All existing structures encountered within the established lines, grades, or grading sections shall be removed by the Contractor, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work or to remain in place. The cost of removing such existing structures shall not be measured or paid for directly, but shall be included in the various contract items.

Should the Contractor encounter an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the Resident Project Representative (DEN PM) shall be notified prior to disturbing such structure. The disposition of existing structures so encountered shall be immediately determined by the DEN PM in accordance with the provisions of the contract.

Except as provided in Section 40, paragraph 40-07, *Rights in and Use of Materials Found in the Work*, it is intended that all existing materials or structures that may be encountered (within the lines, grades, or grading sections established for completion of the work) shall be used in the work as otherwise provided for in the contract and shall remain the property of the Owner when so used in the work.

**40-07 Rights in and use of materials found in the work.** Should the Contractor encounter any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, the use of which is intended by the terms of the contract to be embankment, the Contractor may at their own option either:

- a. Use such material in another contract item, providing such use is approved by the DEN PM and is in conformance with the contract specifications applicable to such use; or,
- b. Remove such material from the site, upon written approval of the DEN PM; or
- c. Use such material for the Contractor's own temporary construction on site; or,
- d. Use such material as intended by the terms of the contract.

Should the Contractor wish to exercise option a., b., or c., the Contractor shall request the DEN PM's approval in advance of such use.

Should the DEN PM approve the Contractor's request to exercise option a., b., or c., the Contractor shall be paid for the excavation or removal of such material at the applicable contract price. The Contractor shall replace, at their expense, such removed or excavated material with an agreed equal volume of material that is acceptable for use in constructing embankment, backfills, or otherwise to the extent that such replacement material is needed to complete the contract work. The Contractor shall not be charged for use of such material used in the work or removed from the site.

Should the DEN PM approve the Contractor's exercise of option a., the Contractor shall be paid, at the applicable contract price, for furnishing and installing such material in accordance with requirements of the contract item in which the material is used.

It is understood and agreed that the Contractor shall make no claim for delays by reason of their own exercise of option a., b., or c.

The Contractor shall not excavate, remove, or otherwise disturb any material, structure, or part of a structure which is located outside the lines, grades, or grading sections established for the work, except where such excavation or removal is provided for in the contract, plans, or specifications.

**40-08 Final cleanup.** Upon completion of the work and before acceptance and final payment will be made, the Contractor shall remove from the site all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees. The Contractor shall cut all brush and woods within the limits indicated and shall leave the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property will not be considered as having been disposed of satisfactorily, unless the Contractor has obtained the written permission of the property Owner.

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**END OF SECTION 40**

## Section 50 Control of Work

**50-01 Authority of the DEN Project Manager (DEN PM).** The DEN PM has final authority regarding the interpretation of project specification requirements. The DEN PM shall determine acceptability of the quality of materials furnished, method of performance of work performed, and the manner and rate of performance of the work. The DEN PM does not have the authority to accept work that does not conform to specification requirements.

**50-02 Conformity with plans and specifications.** All work and all materials furnished shall be in reasonably close conformity with the lines, grades, grading sections, cross-sections, dimensions, material requirements, and testing requirements that are specified (including specified tolerances) in the contract, plans, or specifications.

If the DEN PM finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications, but that the portion of the work affected will, in their opinion, result in a finished product having a level of safety, economy, durability, and workmanship acceptable to the Owner, the DEN PM will advise the Owner of their determination that the affected work be accepted and remain in place. The DEN PM will document the determination and recommend to the Owner a basis of acceptance that will provide for an adjustment in the contract price for the affected portion of the work. Changes in the contract price must be covered by contract change order or supplemental agreement as applicable.

If the DEN PM finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor in accordance with the DEN PM's written orders.

The term "reasonably close conformity" shall not be construed as waiving the Contractor's responsibility to complete the work in accordance with the contract, plans, and specifications. The term shall not be construed as waiving the DEN PM's responsibility to insist on strict compliance with the requirements of the contract, plans, and specifications during the Contractor's execution of the work, when, in the DEN PM's opinion, such compliance is essential to provide an acceptable finished portion of the work.

The term "reasonably close conformity" is also intended to provide the DEN PM with the authority, after consultation with the Sponsor and FAA, to use sound engineering judgment in their determinations to accept work that is not in strict conformity, but will provide a finished product equal to or better than that required by the requirements of the contract, plans and specifications.

The DEN PM will not be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction or the safety precautions incident thereto.

**50-03 Coordination of contract, plans, and specifications.** The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. If electronic files are provided and used on the project and there is a conflict between the electronic files and hard copy plans, the hard copy plans shall govern. A

requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; contract technical specifications shall govern over contract general provisions, plans, cited standards for materials or testing, and cited advisory circulars (ACs); contract general provisions shall govern over plans, cited standards for materials or testing, and cited ACs; plans shall govern over cited standards for materials or testing and cited ACs. If any paragraphs contained in the Special Provisions conflict with General Provisions or Technical Specifications, the Special Provisions shall govern.

From time to time, discrepancies within cited testing standards occur due to the timing of the change, edits, and/or replacement of the standards. If the Contractor discovers any apparent discrepancy within standard test methods, the Contractor shall immediately ask the DEN PM for an inteDEN PMetation and decision, and such decision shall be final.

The Contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the Contractor discovers any apparent error or discrepancy, Contractor shall immediately notify the Owner or the designated representative in writing requesting their written interpretation and decision.

**50-04 List of Special Provisions.** Not used.

**50-05 Cooperation of Contractor.** The Contractor shall be supplied with an electronic PDF of the plans and specifications. The Contractor shall have available on the construction site at all times one hardcopy each of the plans and specifications. Additional hard copies of plans and specifications may be obtained by the Contractor for the cost of reproduction.

The Contractor shall give constant attention to the work to facilitate the progress thereof, and shall cooperate with the DEN PM and their inspectors and with other Contractors in every way possible. The Contractor shall have a competent superintendent on the work at all times who is fully authorized as their agent on the work. The superintendent shall be capable of reading and thoroughly understanding the plans and specifications and shall receive and fulfill instructions from the DEN PM or their authorized representative.

**50-06 Cooperation between Contractors.** The Owner reserves the right to contract for and perform other or additional work on or near the work covered by this contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct the work not to interfere with or hinder the progress of completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with their own contract and shall protect and hold harmless the Owner from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange their work and shall place and dispose of the materials being used to not interfere with the operations of the other Contractors within the limits of the same project. The Contractor shall join their work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

**50-07 Construction layout and stakes.** The Engineer/DEN PM shall establish necessary horizontal and vertical control. The establishment of Survey Control and/or reestablishment of survey control shall be by a State Licensed Land Surveyor. Contractor is responsible for preserving integrity of horizontal and vertical controls established by Engineer/DEN PM. In case

of negligence on the part of the Contractor or their employees, resulting in the destruction of any horizontal and vertical control, the resulting costs will be deducted as a liquidated damage against the Contractor.

Prior to the start of construction, the Contractor will check all control points for horizontal and vertical accuracy and certify in writing to the DEN PM that the Contractor concurs with survey control established for the project. All lines, grades and measurements from control points necessary for the proper execution and control of the work on this project will be provided to the DEN PM. The Contractor is responsible to establish all layout required for the construction of the project.

Copies of survey notes will be provided to the DEN PM for each area of construction and for each placement of material as specified to allow the DEN PM to make periodic checks for conformance with plan grades, alignments and grade tolerances required by the applicable material specifications. Surveys will be provided to the DEN PM prior to commencing work items that cover or disturb the survey staking. Survey(s) and notes shall be provided in the following format(s): electronic and hardcopies.)

Laser, GPS, String line, or other automatic control shall be checked with temporary control as necessary. In the case of error, on the part of the Contractor, their surveyor, employees or subcontractors, resulting in established grades, alignment or grade tolerances that do not concur with those specified or shown on the plans, the Contractor is solely responsible for correction, removal, replacement and all associated costs at no additional cost to the Owner.

No direct payment will be made, unless otherwise specified in contract documents, for this labor, materials, or other expenses. The cost shall be included in the price of the bid for the various items of the Contract.

**50-08 Authority and duties of Quality Assurance (QA) inspectors.** QA inspectors shall be authorized to inspect all work done and all material furnished. Such QA inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. QA inspectors are not authorized to revoke, alter, or waive any provision of the contract. QA inspectors are not authorized to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

QA Inspectors are authorized to notify the Contractor or their representatives of any failure of the work or materials to conform to the requirements of the contract, plans, or specifications and to reject such nonconforming materials in question until such issues can be referred to the DEN PM for a decision.

**50-09 Inspection of the work.** All materials and each part or detail of the work shall be subject to inspection. The DEN PM shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the DEN PM requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be at the Contractor's expense.

Provide advance written notice to the DEN PM of work the Contractor plans to perform each week and each day. Any work done or materials used without written notice and allowing opportunity for inspection by the DEN PM may be ordered removed and replaced at the Contractor's expense.

Should the contract work include relocation, adjustment, or any other modification to existing facilities, not the property of the (contract) Owner, authorized representatives of the Owners of such facilities shall have the right to inspect such work. Such inspection shall in no sense make any facility owner a party to the contract, and shall in no way interfere with the rights of the parties to this contract.

**50-10 Removal of unacceptable and unauthorized work.** All work that does not conform to the requirements of the contract, plans, and specifications will be considered unacceptable, unless otherwise determined acceptable by the DEN PM as provided in paragraph 50-02, *Conformity with Plans and Specifications*.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner in accordance with the provisions of Section 70, paragraph 70-14, *Contractor's Responsibility for Work*.

No removal work made under provision of this paragraph shall be done without lines and grades having been established by the DEN PM. Work done contrary to the instructions of the DEN PM, work done beyond the lines shown on the plans or as established by the DEN PM, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply with any order of the DEN PM made under the provisions of this subsection, the DEN PM will have authority to cause unacceptable work to be remedied or removed and replaced; and unauthorized work to be removed and recover the resulting costs as a liquidated damage against the Contractor.

**50-11 Load restrictions.** The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the work. A special permit will not relieve the Contractor of liability for damage that may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or to any other type of construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete pavement, base, or structure before the expiration of the curing period. The Contractor, at their own expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel.

**50-12 Maintenance during construction.** The Contractor shall maintain the work during construction and until the work is accepted. Maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the work is maintained in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various contract items, and the Contractor will not be paid an additional amount for such work.

**50-13 Failure to maintain the work.** Should the Contractor at any time fail to maintain the work as provided in paragraph 50-12, *Maintenance during Construction*, the DEN PM shall immediately notify the Contractor of such noncompliance. Such notification shall specify a reasonable time within which the Contractor shall be required to remedy such unsatisfactory maintenance condition. The time specified will give due consideration to the exigency that exists.

Should the Contractor fail to respond to the DEN PM's notification, the Owner may suspend any work necessary for the Owner to correct such unsatisfactory maintenance condition, depending on the exigency that exists. Any maintenance cost incurred by the Owner, shall be recovered as a liquidated damage against the Contractor.

**50-14 Partial acceptance.** If at any time during the execution of the project the Contractor substantially completes a usable unit or portion of the work, the occupancy of which will benefit the Owner, the Contractor may request the DEN PM to make final inspection of that unit. If the DEN PM finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, the DEN PM may accept it as being complete, and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance and beneficial occupancy by the Owner shall not void or alter any provision of the contract.

**50-15 Final acceptance.** Upon due notice from the Contractor of presumptive completion of the entire project, the DEN PM and Owner will make an inspection. If all construction provided for and contemplated by the contract is found to be complete in accordance with the contract, plans, and specifications, such inspection shall constitute the final inspection. The DEN PM shall notify the Contractor in writing of final acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the DEN PM will notify the Contractor and the Contractor shall correct the unsatisfactory work. Upon correction of the work, another inspection will be made which shall constitute the final inspection, provided the work has been satisfactorily completed. In such event, the DEN PM will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

**50-16 Claims for adjustment and disputes.** If for any reason the Contractor deems that additional compensation is due for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized as extra work, the Contractor shall notify the DEN PM in writing of their intention to claim such additional compensation before the Contractor begins the work on which the Contractor bases the claim. If such notification is not given or the DEN PM is not afforded proper opportunity by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor and the fact that the DEN PM has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the Contractor shall, within 10 calendar days, submit a written claim to the DEN PM who will present it to the Owner for consideration in accordance with local laws or ordinances.

Nothing in this subsection shall be construed as a waiver of the Contractor's right to dispute final payment based on differences in measurements or computations.

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 50 CONTROL OF WORK**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**END OF SECTION 50**

## Section 60 Control of Materials

**60-01 Source of supply and quality requirements.** The materials used in the work shall conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials that are manufactured or processed shall be new (as compared to used or reprocessed).

In order to expedite the inspection and testing of materials, the Contractor shall furnish documentation to the DEN PM as to the origin, composition, and manufacture of all materials to be used in the work. Documentation shall be furnished promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the DEN PM's option, materials may be approved at the source of supply before delivery. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources.

The Contractor shall furnish airport lighting equipment that meets the requirements of the specifications; and is listed in AC 150/5345-53, *Airport Lighting Equipment Certification Program and Addendum*, that is in effect on the date of advertisement.

**60-02 Samples, tests, and cited specifications.** All materials used in the work shall be inspected, tested, and approved by the DEN PM before incorporation in the work unless otherwise designated. Any work in which untested materials are used without approval or written permission of the DEN PM shall be performed at the Contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the DEN PM, shall be removed at the Contractor's expense.

Unless otherwise designated, quality assurance tests will be made by and at the expense of the Owner in accordance with the cited standard methods of ASTM, American Association of State Highway and Transportation Officials (AASHTO), federal specifications, Commercial Item Descriptions, and all other cited methods, which are current on the date of advertisement for bids.

The testing organizations performing on-site quality assurance field tests shall have copies of all referenced standards on the construction site for use by all technicians and other personnel. Unless otherwise designated, samples for quality assurance will be taken by a qualified representative of the DEN PM. All materials being used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. Copies of all tests will be furnished to the Contractor's representative at their request after review and approval of the DEN PM.

A copy of all Contractor QC test data shall be provided to the DEN PM daily, along with printed reports, in an approved format, on a weekly basis. After completion of the project, and prior to final payment, the Contractor shall submit a final report to the DEN PM showing all test data reports, plus an analysis of all results showing ranges, averages, and corrective action taken on all failing tests.

The Contractor shall employ a Quality Control (QC) testing organization to perform all Contractor required QC tests in accordance with Item C-100 Contractor Quality Control Program (CQCP).

**60-03 Certification of compliance/analysis (COC/COA).** The DEN PM may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's COC stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or assemblies delivered to the work must be accompanied by a certificate of compliance in which the lot is clearly identified. The COA is the manufacturer's COC and includes all applicable test results.

Materials or assemblies used on the basis of certificates of compliance may be sampled and tested at any time and if found not to be in conformity with contract requirements will be subject to rejection whether in place or not.

The form and distribution of certificates of compliance shall be as approved by the DEN PM.

When a material or assembly is specified by "brand name or equal" and the Contractor elects to furnish the specified "or equal," the Contractor shall be required to furnish the manufacturer's certificate of compliance for each lot of such material or assembly delivered to the work. Such certificate of compliance shall clearly identify each lot delivered and shall certify as to:

- a. Conformance to the specified performance, testing, quality or dimensional requirements; and,
- b. Suitability of the material or assembly for the use intended in the contract work.

The DEN PM shall be the sole judge as to whether the proposed "or equal" is suitable for use in the work.

The DEN PM reserves the right to refuse permission for use of materials or assemblies on the basis of certificates of compliance.

**60-04 Plant inspection.** The DEN PM or their authorized representative may inspect, at its source, any specified material or assembly to be used in the work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the work and to obtain samples required for acceptance of the material or assembly.

Should the DEN PM conduct plant inspections, the following conditions shall exist:

- a. The DEN PM shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.
- b. The DEN PM shall have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.
- c. If required by the DEN PM, the Contractor shall arrange for adequate office or working space that may be reasonably needed for conducting plant inspections. Place office or working space in a convenient location with respect to the plant.

It is understood and agreed that the Owner shall have the right to retest any material that has been tested and approved at the source of supply after it has been delivered to the site. The DEN PM shall have the right to reject only material which, when retested, does not meet the requirements of the contract, plans, or specifications.

**60-05 Engineer/ DEN Project Manager (DEN PM) field office.** An Engineer/DEN PM field office is not required.

**60-06 Storage of materials.** Materials shall be stored to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be

inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. The Contractor shall coordinate the storage of all materials with the DEN PM. Materials to be stored on airport property shall not create an obstruction to air navigation nor shall they interfere with the free and unobstructed movement of aircraft. Unless otherwise shown on the plans and/or CSPP, the storage of materials and the location of the Contractor's plant and parked equipment or vehicles shall be as directed by the DEN PM. Private property shall not be used for storage purposes without written permission of the Owner or lessee of such property. The Contractor shall make all arrangements and bear all expenses for the storage of materials on private property. Upon request, the Contractor shall furnish the DEN PM a copy of the property Owner's permission.

All storage sites on private or airport property shall be restored to their original condition by the Contractor at their expense, except as otherwise agreed to (in writing) by the Owner or lessee of the property.

**60-07 Unacceptable materials.** Any material or assembly that does not conform to the requirements of the contract, plans, or specifications shall be considered unacceptable and shall be rejected. The Contractor shall remove any rejected material or assembly from the site of the work, unless otherwise instructed by the DEN PM.

Rejected material or assembly, the defects of which have been corrected by the Contractor, shall not be returned to the site of the work until such time as the DEN PM has approved its use in the work.

**60-08 Owner furnished materials.** The Contractor shall furnish all materials required to complete the work, except those specified, if any, to be furnished by the Owner. Owner-furnished materials shall be made available to the Contractor at the location specified.

All costs of handling, transportation from the specified location to the site of work, storage, and installing Owner-furnished materials shall be included in the unit price bid for the contract item in which such Owner-furnished material is used.

After any Owner-furnished material has been delivered to the location specified, the Contractor shall be responsible for any demurrage, damage, loss, or other deficiencies that may occur during the Contractor's handling, storage, or use of such Owner-furnished material. The Owner will deduct from any monies due or to become due the Contractor any cost incurred by the Owner in making good such loss due to the Contractor's handling, storage, or use of Owner-furnished materials.

**END OF SECTION 60**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 60 CONTROL OF MATERIALS**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## **Section 70 Legal Regulations and Responsibility to Public**

**70-01 Laws to be observed.** The Contractor shall keep fully informed of all federal and state laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the Owner and all their officers, agents, or servants against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor's employees.

**70-02 Permits, licenses, and taxes.** The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful execution of the work.

**70-03 Patented devices, materials, and processes.** If the Contractor is required or desires to use any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the Patentee or Owner. The Contractor and the surety shall indemnify and hold harmless the Owner, any third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Owner for any costs, expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the execution or after the completion of the work.

**70-04 Restoration of surfaces disturbed by others.** The Owner reserves the right to authorize the construction, reconstruction, or maintenance of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA) facility, or a utility service of another government agency at any time during the progress of the work. To the extent that such construction, reconstruction, or maintenance has been coordinated with the Owner, such authorized work (by others) must be shown on the plans and is indicated as follows: See section 011810, Utilities Interface, subsection 1.2B for a listing of the applicable utility owners.

Except as listed above, the Contractor shall not permit any individual, firm, or corporation to excavate or otherwise disturb such utility services or facilities located within the limits of the work without the written permission of the DEN PM.

Should the Owner of public or private utility service, FAA, or NOAA facility, or a utility service of another government agency be authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the Contractor shall cooperate with such Owners by arranging and performing the work in this contract to facilitate such construction, reconstruction or maintenance by others whether or not such work by others is listed above. When ordered as extra work by the DEN PM, the Contractor shall make all necessary repairs to the work which are due to such authorized work by others, unless otherwise provided for in the contract, plans, or specifications. It is understood and agreed that the Contractor shall not be entitled to make any claim for damages due to such authorized work by others or for any delay to the work resulting from such authorized work.

**70-05 Federal Participation.** The United States Government has agreed to reimburse the Owner for some portion of the contract costs. The contract work is subject to the inspection and

approval of duly authorized representatives of the FAA Administrator. No requirement of this contract shall be construed as making the United States a party to the contract nor will any such requirement interfere, in any way, with the rights of either party to the contract.

**70-06 Sanitary, health, and safety provisions.** The Contractor's worksite and facilities shall comply with applicable federal, state, and local requirements for health, safety and sanitary provisions.

**70-07 Public convenience and safety.** The Contractor shall control their operations and those of their subcontractors and all suppliers, to assure the least inconvenience to the traveling public. Under all circumstances, safety shall be the most important consideration.

The Contractor shall maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to their own operations and those of their own subcontractors and all suppliers in accordance with Section 40, paragraph 40-05, *Maintenance of Traffic*, and shall limit such operations for the convenience and safety of the traveling public as specified in Section 80, paragraph 80-04, *Limitation of Operations*.

The Contractor shall remove or control debris and rubbish resulting from its work operations at frequent intervals, and upon the order of the DEN PM. If the DEN PM determines the existence of Contractor debris in the work site represents a hazard to airport operations and the Contractor is unable to respond in a prompt and reasonable manner, the DEN PM reserves the right to assign the task of debris removal to a third party and recover the resulting costs as a liquidated damage against the Contractor.

**70-08 Construction Safety and Phasing Plan (CSPP).** The Contractor shall complete the work in accordance with the approved Construction Safety and Phasing Plan (CSPP) developed in accordance with AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP is on the GC sheet(s) of the project plans.

**70-09 Use of explosives.** The use of explosives is not permitted on this project. DEN PM

**70-10 Protection and restoration of property and landscape.** The Contractor shall be responsible for the preservation of all public and private property, and shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer/DEN PM has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be responsible for all damage or injury to property of any character, during the execution of the work, resulting from any act, omission, neglect, or misconduct in manner or method of executing the work, or at any time due to defective work or materials, and said responsibility shall not be released until the project has been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof by the Contractor, the Contractor shall restore, at their expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner.

**70-11 Responsibility for damage claims.** The Contractor shall indemnify and hold harmless the Engineer/DEN PM and the Owner and their officers, agents, and employees from all suits, actions, or claims, of any character, brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any

infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, ordinance, order, or decree. Money due the Contractor under and by virtue of their own contract considered necessary by the Owner for such purpose may be retained for the use of the Owner or, in case no money is due, their own surety may be held until such suits, actions, or claims for injuries or damages shall have been settled and suitable evidence to that effect furnished to the Owner, except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he or she is adequately protected by public liability and property damage insurance.

**70-12 Third party beneficiary clause.** It is specifically agreed between the parties executing the contract that it is not intended by any of the provisions of any part of the contract to create for the public or any member thereof, a third-party beneficiary or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

**70-13 Opening sections of the work to traffic.** If it is necessary for the Contractor to complete portions of the contract work for the beneficial occupancy of the Owner prior to completion of the entire contract, such "phasing" of the work must be specified below and indicated on the approved Construction Safety and Phasing Plan (CSPP) and the project plans. When so specified, the Contractor shall complete such portions of the work on or before the date specified or as otherwise specified.

Refer to the phasing plans of the construction drawings. .

- **Required Date or Sequence of Owner's Beneficial Occupancy**
- **Work Shown on Plan Sheet**

Upon completion of any portion of work listed above, such portion shall be accepted by the Owner in accordance with Section 50, paragraph 50-14, *Partial Acceptance*.

No portion of the work may be opened by the Contractor until directed by the Owner in writing. Should it become necessary to open a portion of the work to traffic on a temporary or intermittent basis, such openings shall be made when, in the opinion of the DEN PM, such portion of the work is in an acceptable condition to support the intended traffic. Temporary or intermittent openings are considered to be inherent in the work and shall not constitute either acceptance of the portion of the work so opened or a waiver of any provision of the contract. Any damage to the portion of the work so opened that is not attributable to traffic which is permitted by the Owner shall be repaired by the Contractor at their expense.

The Contractor shall make their own estimate of the inherent difficulties involved in completing the work under the conditions herein described and shall not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work.

The Contractor must conform to safety standards contained AC 150/5370-2 and the approved CSPP.

Contractor shall refer to the plans, specifications, and the approved CSPP to identify barricade requirements, temporary and/or permanent markings, airfield lighting, guidance signs and other safety requirements prior to opening up sections of work to traffic.

**70-14 Contractor's responsibility for work.** Until the DEN PM's final written acceptance of the entire completed work, excepting only those portions of the work accepted in accordance with Section 50, paragraph 50-14, *Partial Acceptance*, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part due to the action of

the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of government authorities.

If the work is suspended for any cause whatever, the Contractor shall be responsible for the work and shall take such precautions necessary to prevent damage to the work. The Contractor shall provide for normal drainage and shall erect necessary temporary structures, signs, or other facilities at their own expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established planting, seeding, and sodding furnished under the contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

**70-15 Contractor’s responsibility for utility service and facilities of others.** As provided in paragraph 70-04, *Restoration of Surfaces Disturbed by Others*, the Contractor shall cooperate with the owner of any public or private utility service, FAA or NOAA, or a utility service of another government agency that may be authorized by the Owner to construct, reconstruct or maintain such utility services or facilities during the progress of the work. In addition, the Contractor shall control their operations to prevent the unscheduled interruption of such utility services and facilities.

To the extent that such public or private utility services, FAA, or NOAA facilities, or utility services of another governmental agency are known to exist within the limits of the contract work, the approximate locations have been indicated on the plans and/or in the contract documents.

It is understood and agreed that the Owner does not guarantee the accuracy or the completeness of the location information relating to existing utility services, facilities, or structures that may be shown on the plans or encountered in the work. Any inaccuracy or omission in such information shall not relieve the Contractor of the responsibility to protect such existing features from damage or unscheduled interruption of service.

It is further understood and agreed that the Contractor shall, upon execution of the contract, notify the Owners of all utility services or other facilities of their plan of operations. Such notification shall be in writing addressed to “The Person to Contact” as provided in this paragraph and paragraph 70-04, *Restoration of Surfaces Disturbed By Others*. A copy of each notification shall be given to the DEN PM.

In addition to the general written notification provided, it shall be the responsibility of the Contractor to keep such individual Owners advised of changes in their plan of operations that would affect such Owners.

Prior to beginning the work in the general vicinity of an existing utility service or facility, the Contractor shall again notify each such Owner of their plan of operation. If, in the Contractor’s opinion, the Owner’s assistance is needed to locate the utility service or facility or the presence of a representative of the Owner is desirable to observe the work, such advice should be included in the notification. Such notification shall be given by the most expeditious means to reach the utility owner’s “Person to Contact” no later than two normal business days prior to the

Contractor's commencement of operations in such general vicinity. The Contractor shall furnish a written summary of the notification to the DEN PM.

The Contractor's failure to give the two days' notice shall be cause for the Owner to suspend the Contractor's operations in the general vicinity of a utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the Contractor shall be required to use hand excavation methods within 3 feet (1 m) of such outside limits at such points as may be required to ensure protection from damage due to the Contractor's operations.

Should the Contractor damage or interrupt the operation of a utility service or facility by accident or otherwise, the Contractor shall immediately notify the proper authority and the DEN PM and shall take all reasonable measures to prevent further damage or interruption of service. The Contractor, in such events, shall cooperate with the utility service or facility owner and the DEN PM continuously until such damage has been repaired and service restored to the satisfaction of the utility or facility owner.

The Contractor shall bear all costs of damage and restoration of service to any utility service or facility due to their operations whether due to negligence or accident. The Owner reserves the right to deduct such costs from any monies due or which may become due the Contractor, or their own surety.

**70-15.1 FAA facilities and cable runs.** The Contractor is hereby advised that the construction limits of the project include existing facilities and buried cable runs that are owned, operated and maintained by the FAA. The Contractor, during the execution of the project work, shall comply with the following:

**a.** The Contractor shall permit FAA maintenance personnel the right of access to the project work site for purposes of inspecting and maintaining all existing FAA owned facilities.

**b.** The Contractor shall provide notice to the FAA Air Traffic Organization (ATO)/Technical Operations/System Support Center (SSC) Point-of-Contact through the airport DEN PM a minimum of seven (7) calendar days prior to commencement of construction activities in order to permit sufficient time to locate and mark existing buried cables and to schedule any required facility outages.

**c.** If execution of the project work requires a facility outage, the Contractor shall contact the FAA Point-of-Contact a minimum of 72 hours prior to the time of the required outage.

**d.** Any damage to FAA cables, access roads, or FAA facilities during construction caused by the Contractor's equipment or personnel whether by negligence or accident will require the Contractor to repair or replace the damaged cables, access road, or FAA facilities to FAA requirements. The Contractor shall not bear the cost to repair damage to underground facilities or utilities improperly located by the FAA.

**e.** If the project work requires the cutting or splicing of FAA owned cables, the FAA Point-of-Contact shall be contacted a minimum of 72 hours prior to the time the cable work commences. The FAA reserves the right to have a FAA representative on site to observe the splicing of the cables as a condition of acceptance. All cable splices are to be accomplished in accordance with FAA specifications and require approval by the FAA Point-of-Contact as a condition of acceptance by the Owner. The Contractor is hereby advised that FAA restricts the location of where splices may be installed. If a cable splice is required in a location that is not permitted by FAA, the Contractor shall furnish and install a sufficient length of new cable that eliminates the need for any splice.

**70-16 Furnishing rights-of-way.** The Owner will be responsible for furnishing all rights-of-way upon which the work is to be constructed in advance of the Contractor's operations.

**70-17 Personal liability of public officials.** In carrying out any of the contract provisions or in exercising any power or authority granted by this contract, there shall be no liability upon the Engineer, DEN PM, their authorized representatives, or any officials of the Owner either personally or as an official of the Owner. It is understood that in such matters they act solely as agents and representatives of the Owner.

**70-18 No waiver of legal rights.** Upon completion of the work, the Owner will expeditiously make final inspection and notify the Contractor of final acceptance. Such final acceptance, however, shall not preclude or stop the Owner from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Owner be precluded or stopped from recovering from the Contractor or their surety, or both, such overpayment as may be sustained, or by failure on the part of the Contractor to fulfill their obligations under the contract. A waiver on the part of the Owner of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Owner for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Owner's rights under any warranty or guaranty.

**70-19 Environmental protection.** The Contractor shall comply with all federal, state, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuels, oils, asphalts, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

**70-20 Archaeological and historical findings.** Unless otherwise specified in this subsection, the Contractor is advised that the site of the work is not within any property, district, or site, and does not contain any building, structure, or object listed in the current National Register of Historic Places published by the United States Department of Interior.

Should the Contractor encounter, during their operations, any building, part of a building, structure, or object that is incongruous with its surroundings, the Contractor shall immediately cease operations in that location and notify the DEN PM. The DEN PM will immediately investigate the Contractor's finding and the Owner will direct the Contractor to either resume operations or to suspend operations as directed.

Should the Owner order suspension of the Contractor's operations in order to protect an archaeological or historical finding, or order the Contractor to perform extra work, such shall be covered by an appropriate contract change order or supplemental agreement as provided in Section 40, paragraph 40-04, *Extra Work*, and Section 90, paragraph 90-05, *Payment for Extra Work*. If appropriate, the contract change order or supplemental agreement shall include an extension of contract time in accordance with Section 80, paragraph 80-07, *Determination and Extension of Contract Time*.

## END OF SECTION 70

## Section 80 Execution and Progress

**80-01 Subletting of contract.** The Owner will not recognize any subcontractor on the work. The Contractor shall at all times when work is in progress be represented either in person, by a qualified superintendent, or by other designated, qualified representative who is duly authorized to receive and execute orders of the DEN Project Manager (DEN PM).

The Contractor shall perform, with his organization, an amount of work equal to at least 40 percent of the total contract cost.

Should the Contractor elect to assign their contract, said assignment shall be concurred in by the surety, shall be presented for the consideration and approval of the Owner, and shall be consummated only on the written approval of the Owner.

The Contractor shall provide copies of all subcontracts to the DEN PM 14 days prior to being utilized on the project. As a minimum, the information shall include the following:

- Subcontractor's legal company name.
- Subcontractor's legal company address, including County name.
- Principal contact person's name, telephone and fax number.
- Complete narrative description, and dollar value of the work to be performed by the subcontractor.
- Copies of required insurance certificates in accordance with the specifications.
- Minority/ non-minority status.

**80-02 Notice to proceed (NTP).** The Owners notice to proceed will state the date on which contract time commences. The Contractor is expected to commence project operations within 10 days of the NTP date. The Contractor shall notify the DEN PM at least 24 hours in advance of the time contract operations begins. The Contractor shall not commence any actual operations prior to the date on which the notice to proceed is issued by the Owner.

**80-03 Execution and progress.** Unless otherwise specified, the Contractor shall submit their coordinated construction schedule showing all work activities for the DEN PM's review and acceptance at least 10 days prior to the start of work. The Contractor's progress schedule, once accepted by the DEN PM, will represent the Contractor's baseline plan to accomplish the project in accordance with the terms and conditions of the Contract. The DEN PM will compare actual Contractor progress against the baseline schedule to determine that status of the Contractor's performance. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the proposal.

If the Contractor falls significantly behind the submitted schedule, the Contractor shall, upon the DEN PM's request, submit a revised schedule for completion of the work within the contract time and modify their operations to provide such additional materials, equipment, and labor necessary to meet the revised schedule. Should the execution of the work be discontinued for

any reason, the Contractor shall notify the DEN PM at least 24 hours in advance of resuming operations.

The Contractor shall not commence any actual construction prior to the date on which the NTP is issued by the Owner.

The project schedule shall be prepared as a network diagram in Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), or other format, or as otherwise specified. It shall include information on the sequence of work activities, milestone dates, and activity duration. The schedule shall show all work items identified in the project proposal for each work area and shall include the project start date and end date.

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

**80-04 Limitation of operations.** The Contractor shall control their operations and the operations of their subcontractors and all suppliers to provide for the free and unobstructed movement of aircraft in the air operations areas (AOA) of the airport.

When the work requires the Contractor to conduct their operations within an AOA of the airport, the work shall be coordinated with airport operations (through the DEN PM) at least 48 hours prior to commencement of such work. The Contractor shall not close an AOA until so authorized by the DEN PM and until the necessary temporary marking, signage and associated lighting is in place as provided in Section 70, paragraph 70-08, *Construction Safety and Phasing Plan (CSPP)*.

When the contract work requires the Contractor to work within an AOA of the airport on an intermittent basis (intermittent opening and closing of the AOA), the Contractor shall maintain constant communications as specified; immediately obey all instructions to vacate the AOA; and immediately obey all instructions to resume work in such AOA. Failure to maintain the specified communications or to obey instructions shall be cause for suspension of the Contractor's operations in the AOA until satisfactory conditions are provided. The areas of the AOA identified in the Construction Safety Phasing Plan (CSPP) and as listed below, cannot be closed to operating aircraft to permit the Contractor's operations on a continuous basis and will therefore be closed to aircraft operations intermittently as follows:

Refer to the Milestone Sheets of the Construction Drawings.

The Contractor shall be required to conform to safety standards contained in AC 150/5370-2, Operational Safety on Airports During Construction and the approved CSPP.

**80-04.1 Operational safety on airport during construction.** All Contractors' operations shall be conducted in accordance with the approved project Construction Safety and Phasing Plan (CSPP) and the Safety Plan Compliance Document (SPCD) and the provisions set forth within the current version of AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP included within the contract documents conveys minimum requirements for operational safety on the airport during construction activities. The Contractor shall prepare and submit a SPCD that details how it proposes to comply with the requirements presented within the CSPP.

The Contractor shall implement all necessary safety plan measures prior to commencement of any work activity. The Contractor shall conduct routine checks to assure compliance with the safety plan measures.

The Contractor is responsible to the Owner for the conduct of all subcontractors it employs on the project. The Contractor shall assure that all subcontractors are made aware of the requirements of the CSPP and SPCD and that they implement and maintain all necessary measures.

No deviation or modifications may be made to the approved CSPP and SPCD unless approved in writing by the Owner. The necessary coordination actions to review Contractor proposed modifications to an approved CSPP or approved SPCD can require a significant amount of time.

**80-05 Character of workers, methods, and equipment.** The Contractor shall, at all times, employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by the contract, plans, and specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the Contractor or by any subcontractor who violates any operational regulations or operational safety requirements and, in the opinion of the DEN PM, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the DEN PM, be removed immediately by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without approval of the DEN PM.

Should the Contractor fail to remove such person or persons, or fail to furnish suitable and sufficient personnel for the proper execution of the work, the DEN PM may suspend the work by written notice until compliance with such orders.

All equipment that is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the work shall not cause injury to previously completed work, adjacent property, or existing airport facilities due to its use.

When the methods and equipment to be used by the Contractor in accomplishing the work are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the work in conformity with the requirements of the contract, plans, and specifications.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless otherwise authorized by the DEN PM. If the Contractor desires to use a method or type of equipment other than specified in the contract, the Contractor may request authority from the DEN PM to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the DEN PM determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove any deficient work and replace it with work of specified quality, or take such other corrective action as the DEN PM may direct. No change will be made in basis of payment for the contract items involved nor in contract time as a result of authorizing a change in methods or equipment under this paragraph.

**80-06 Temporary suspension of the work.** The Owner shall have the authority to suspend the work wholly, or in part, for such period or periods the Owner may deem necessary, due to

unsuitable weather, or other conditions considered unfavorable for the execution of the work, or for such time necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract.

In the event that the Contractor is ordered by the Owner, in writing, to suspend work for some unforeseen cause not otherwise provided for in the contract and over which the Contractor has no control, the Contractor may be reimbursed for actual money expended on the work during the period of shutdown. No allowance will be made for anticipated profits. The period of shutdown shall be computed from the effective date of the written order to suspend work to the effective date of the written order to resume the work. Claims for such compensation shall be filed with the DEN PM within the time period stated in the DEN PM's order to resume work. The Contractor shall submit with their own claim information substantiating the amount shown on the claim. The DEN PM will forward the Contractor's claim to the Owner for consideration in accordance with local laws or ordinances. No provision of this article shall be construed as entitling the Contractor to compensation for delays due to inclement weather or for any other delay provided for in the contract, plans, or specifications.

If it becomes necessary to suspend work for an indefinite period, the Contractor shall store all materials in such manner that they will not become an obstruction nor become damaged in any way. The Contractor shall take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The Contractor shall erect temporary structures where necessary to provide for traffic on, to, or from the airport.

**80-07 Determination and extension of contract time.** The number of calendar days shall be stated in the proposal and contract and shall be known as the Contract Time.

If the contract time requires extension for reasons beyond the Contractor's control, it shall be adjusted as follows:

**80-07.1 Contract time based on calendar days.** Contract Time based on calendar days shall consist of the number of calendar days stated in the contract counting from the effective date of the Notice to Proceed and including all Saturdays, Sundays, holidays, and non-work days. All calendar days elapsing between the effective dates of the Owner's orders to suspend and resume all work, due to causes not the fault of the Contractor, shall be excluded.

At the time of final payment, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in the contract time shall not consider either cost of work or the extension of contract time that has been covered by a change order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.

**80-08 Failure to complete on time.** For each calendar day or working day, as specified in the contract, that any work remains uncompleted after the contract time (including all extensions and adjustments as provided in paragraph 80-07, *Determination and Extension of Contract Time*) the sum specified in the contract and proposal as liquidated damages (LD) will be deducted from any money due or to become due the Contractor or their own surety. Such deducted sums shall not be deducted as a penalty but shall be considered as liquidation of a reasonable portion of damages including but not limited to additional engineering services that will be incurred by the Owner should the Contractor fail to complete the work in the time provided in their contract.

Schedule	Liquidated Damages Cost	Allowed Construction Time
All	\$7,500/ Day	411 Calendar Days

The maximum construction time allowed for All Schedules combined will be 411 calendar days. Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Owner of any of its rights under the contract.

**The contract time is an essential part of each contract for construction on airports and should be considered carefully in the preparation of plans and specifications.**

**80-09 Default and termination of contract.** The Contractor shall be considered in default of their contract and such default will be considered as cause for the Owner to terminate the contract for any of the following reasons, if the Contractor:

- a. Fails to begin the work under the contract within the time specified in the Notice to Proceed, or
- b. Fails to perform the work or fails to provide sufficient workers, equipment and/or materials to assure completion of work in accordance with the terms of the contract, or
- c. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
- d. Discontinues the execution of the work, or
- e. Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
- f. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
- g. Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 days, or
- h. Makes an assignment for the benefit of creditors, or
- i. For any other cause whatsoever, fails to carry on the work in an acceptable manner.

Should the Owner consider the Contractor in default of the contract for any reason above, the Owner shall immediately give written notice to the Contractor and the Contractor's surety as to the reasons for considering the Contractor in default and the Owner's intentions to terminate the contract.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Owner will, upon written notification from the DEN PM of the facts of such delay, neglect, or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the execution of the work out of the hands of the Contractor. The Owner may appropriate or use any or all materials and equipment that have been mobilized for use in the work and are acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the DEN PM will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Owner, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due the Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the Owner the amount of such excess.

**80-10 Termination for national emergencies.** The Owner shall terminate the contract or portion thereof by written notice when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the execution of war or in the interest of national defense.

When the contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract price or as mutually agreed for items of work partially completed or not started. No claims or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the DEN PM.

Termination of the contract or a portion thereof shall neither relieve the Contractor of their responsibilities for the completed work nor shall it relieve their surety of its obligation for and concerning any just claim arising out of the work performed.

**80-11 Work area, storage area and sequence of operations.** The Contractor shall obtain approval from the DEN PM prior to beginning any work in all areas of the airport. No operating runway, taxiway, or air operations area (AOA) shall be crossed, entered, or obstructed while it is operational. The Contractor shall plan and coordinate work in accordance with the approved CSPP and SPCD.

**END OF SECTION**

## Section 90 Measurement and Payment

**90-01 Measurement of quantities.** All work completed under the contract will be measured by the RPR, or their authorized representatives, using United States Customary Units of Measurement.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (or leave-outs) having an area of 9 square feet (0.8 square meters) or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the RPR.

Unless otherwise specified, all contract items which are measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains, and similar items shall be measured parallel to the base or foundation upon which such items are placed.

The term “lump sum” when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure or structural unit (in effect, “lump sum” work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When requested by the Contractor and approved by the RPR in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed, and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the RPR and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

### Measurement and Payment Terms

Term	Description
<b>Excavation and Embankment Volume</b>	In computing volumes of excavation, the average end area method will be used unless otherwise specified.
<b>Measurement and Proportion by Weight</b>	The term “ton” will mean the short ton consisting of 2,000 pounds (907 kg) avoirdupois. All materials that are measured or proportioned by weights shall be weighed on accurate, independently certified scales by competent, qualified personnel at locations designated by the RPR. If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty.

TECHNICAL SPECIFICATIONS  
 DIVISION 2 – AIRFIELD STANDARDS  
 SECTION 90 MEASUREMENT AND PAYMENT

DENVER INTERNATIONAL AIRPORT  
 TAXIWAY DS EAST  
 CONTRACT NO. 201737642-02

Term	Description
	daily at such times as the RPR directs, and each truck shall bear a plainly legible identification mark.
<b>Measurement by Volume</b>	Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable for the materials hauled, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery.
<b>Asphalt Material</b>	Asphalt materials will be measured by the gallon (liter) or ton (kg). When measured by volume, such volumes will be measured at 60°F (16°C) or will be corrected to the volume at 60°F (16°C) using ASTM D1250 for asphalts. Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when asphalt material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work. When asphalt materials are shipped by truck or transport, net certified weights by volume, subject to correction for loss or foaming, will be used for computing quantities.
<b>Cement</b>	Cement will be measured by the ton (kg) or hundredweight (km).
<b>Structure</b>	Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.
<b>Timber</b>	Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.
<b>Plates and Sheets</b>	The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fraction of inch.
<b>Miscellaneous Items</b>	When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.
<b>Scales</b>	Scales must be tested for accuracy and serviced before use. Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected, and maintained by the Contractor, or be certified permanently installed commercial scales. Platform scales shall be installed and maintained with the platform level and rigid bulkheads at each end.

TECHNICAL SPECIFICATIONS  
 DIVISION 2 – AIRFIELD STANDARDS  
 SECTION 90 MEASUREMENT AND PAYMENT

DENVER INTERNATIONAL AIRPORT  
 TAXIWAY DS EAST  
 CONTRACT NO. 201737642-02

Term	Description
	<p>Scales shall be accurate within 0.5% of the correct weight throughout the range of use. The Contractor shall have the scales checked under the observation of the RPR before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam or dial and shall not exceed 0.1% of the nominal rated capacity of the scale, but not less than one pound (454 grams). The use of spring balances will not be permitted.</p> <p>In the event inspection reveals the scales have been “overweighing” (indicating more than correct weight) they will be immediately adjusted. All materials received subsequent to the last previous correct weighting-accuracy test will be reduced by the percentage of error in excess of 0.5%.</p> <p>In the event inspection reveals the scales have been under-weighing (indicating less than correct weight), they shall be immediately adjusted. No additional payment to the Contractor will be allowed for materials previously weighed and recorded.</p> <p>Beams, dials, platforms, and other scale equipment shall be so arranged that the operator and the RPR can safely and conveniently view them.</p> <p>Scale installations shall have available ten standard 50-pound (2.3 km) weights for testing the weighing equipment or suitable weights and devices for other approved equipment.</p> <p>All costs in connection with furnishing, installing, certifying, testing, and maintaining scales; for furnishing check weights and scale house; and for all other items specified in this subsection, for the weighing of materials for proportioning or payment, shall be included in the unit contract prices for the various items of the project.</p>
<b>Rental Equipment</b>	<p>Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Special equipment ordered in connection with extra work will be measured as agreed in the change order or supplemental agreement authorizing such work as provided in paragraph 90-05 <i>Payment for Extra Work</i>.</p>
<b>Pay Quantities</b>	<p>When the estimated quantities for a specific portion of the work are designated as the pay quantities in the contract, they shall be the final quantities for which payment for such specific portion of the work will be made, unless the dimensions of said portions of the work shown on the plans are revised by the RPR. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment will be revised in the amount represented by the authorized changes in the dimensions.</p>

**90-02 Scope of payment.** The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials, for performing all work under the contract in a complete and acceptable manner, and for all risk, loss, damage, or expense of

whatever character arising out of the nature of the work or the execution thereof, subject to the provisions of Section 70, paragraph 70-18, *No Waiver of Legal Rights*.

When the “basis of payment” subsection of a technical specification requires that the contract price (price bid) include compensation for certain work or material essential to the item, this same work or material will not also be measured for payment under any other contract item which may appear elsewhere in the contract, plans, or specifications.

**90-03 Compensation for altered quantities.** When the accepted quantities of work vary from the quantities in the proposal, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract price for the accepted quantities of work actually completed and accepted. No allowance, except as provided for in Section 40, paragraph 40-02, *Alteration of Work and Quantities*, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor which results directly from such alterations or indirectly from their own unbalanced allocation of overhead and profit among the contract items, or from any other cause.

**90-04 Payment for omitted items.** As specified in Section 40, paragraph 40-03, *Omitted Items*, the RPR shall have the right to omit from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Owner.

Should the RPR omit or order nonperformance of a contract item or portion of such item from the work, the Contractor shall accept payment in full at the contract prices for any work actually completed and acceptable prior to the RPR’s order to omit or non-perform such contract item.

Acceptable materials ordered by the Contractor or delivered on the work prior to the date of the RPR’s order will be paid for at the actual cost to the Contractor and shall thereupon become the property of the Owner.

In addition to the reimbursement hereinbefore provided, the Contractor shall be reimbursed for all actual costs incurred for the purpose of performing the omitted contract item prior to the date of the RPR’s order. Such additional costs incurred by the Contractor must be directly related to the deleted contract item and shall be supported by certified statements by the Contractor as to the nature the amount of such costs.

**90-05 Payment for extra work.** Extra work, performed in accordance with Section 40, paragraph 40-04, *Extra Work*, will be paid for at the contract prices or agreed prices specified in the change order or supplemental agreement authorizing the extra work.

**90-06 Partial payments.** Partial payments will be made to the Contractor at least once each month as the work progresses. Said payments will be based upon estimates, prepared by the RPR, of the value of the work performed and materials complete and in place, in accordance with the contract, plans, and specifications. Such partial payments may also include the delivered actual cost of those materials stockpiled and stored in accordance with paragraph 90-07, *Payment for Materials on Hand*. No partial payment will be made when the amount due to the Contractor since the last estimate amounts to less than five hundred dollars.

It is understood and agreed that the Contractor shall not be entitled to demand or receive partial payment based on quantities of work in excess of those provided in the proposal or covered by approved change orders or supplemental agreements, except when such excess quantities have been determined by the RPR to be a part of the final quantity for the item of work in question.

No partial payment shall bind the Owner to the acceptance of any materials or work in place as to quality or quantity. All partial payments are subject to correction at the time of final payment as provided in paragraph 90-09, *Acceptance and Final Payment*.

The Contractor shall deliver to the Owner a complete release of all claims for labor and material arising out of this contract before the final payment is made. If any subcontractor or supplier fails to furnish such a release in full, the Contractor may furnish a bond or other collateral satisfactory to the Owner to indemnify the Owner against any potential lien or other such claim. The bond or collateral shall include all costs, expenses, and attorney fees the Owner may be compelled to pay in discharging any such lien or claim.

**90-07 Payment for materials on hand.** Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the contract, plans, and specifications and are delivered to acceptable sites on the airport property or at other sites in the vicinity that are acceptable to the Owner. Such delivered costs of stored or stockpiled materials may be included in the next partial payment after the following conditions are met:

a. The material has been stored or stockpiled in a manner acceptable to the RPR at or on an approved site.

b. The Contractor has furnished the RPR with acceptable evidence of the quantity and quality of such stored or stockpiled materials.

c. The Contractor has furnished the RPR with satisfactory evidence that the material and transportation costs have been paid.

d. The Contractor has furnished the Owner legal title (free of liens or encumbrances of any kind) to the material stored or stockpiled.

e. The Contractor has furnished the Owner evidence that the material stored or stockpiled is insured against loss by damage to or disappearance of such materials at any time prior to use in the work.

It is understood and agreed that the transfer of title and the Owner's payment for such stored or stockpiled materials shall in no way relieve the Contractor of their responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans, and specifications.

In no case will the amount of partial payments for materials on hand exceed the contract price for such materials or the contract price for the contract item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the partial payment of stored or stockpiled materials in accordance with the provisions of this paragraph.

**90-08 Payment of withheld funds.** At the Contractor's option, if an Owner withholds retainage in accordance with the methods described in paragraph 90-06 *Partial Payments*, the Contractor may request that the Owner deposit the retainage into an escrow account. The Owner's deposit of retainage into an escrow account is subject to the following conditions:

a. The Contractor shall bear all expenses of establishing and maintaining an escrow account and escrow agreement acceptable to the Owner.

**b.** The Contractor shall deposit to and maintain in such escrow only those securities or bank certificates of deposit as are acceptable to the Owner and having a value not less than the retainage that would otherwise be withheld from partial payment.

**c.** The Contractor shall enter into an escrow agreement satisfactory to the Owner.

**d.** The Contractor shall obtain the written consent of the surety to such agreement.

**90-09 Acceptance and final payment.** When the contract work has been accepted in accordance with the requirements of Section 50, paragraph 50-15, *Final Acceptance*, the RPR will prepare the final estimate of the items of work actually performed. The Contractor shall approve the RPR's final estimate or advise the RPR of the Contractor's objections to the final estimate which are based on disputes in measurements or computations of the final quantities to be paid under the contract as amended by change order or supplemental agreement. The Contractor and the RPR shall resolve all disputes (if any) in the measurement and computation of final quantities to be paid within 30 calendar days of the Contractor's receipt of the RPR's final estimate. If, after such 30-day period, a dispute still exists, the Contractor may approve the RPR's estimate under protest of the quantities in dispute, and such disputed quantities shall be considered by the Owner as a claim in accordance with Section 50, paragraph 50-16, *Claims for Adjustment and Disputes*.

After the Contractor has approved, or approved under protest, the RPR's final estimate, and after the RPR's receipt of the project closeout documentation required in paragraph 90-11, *Contractor Final Project Documentation*, final payment will be processed based on the entire sum, or the undisputed sum in case of approval under protest, determined to be due the Contractor less all previous payments and all amounts to be deducted under the provisions of the contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

If the Contractor has filed a claim for additional compensation under the provisions of Section 50, paragraph 50-16, *Claims for Adjustments and Disputes*, or under the provisions of this paragraph, such claims will be considered by the Owner in accordance with local laws or ordinances. Upon final adjudication of such claims, any additional payment determined to be due the Contractor will be paid pursuant to a supplemental final estimate.

**90-10 Construction warranty.**

**a.** In addition to any other warranties in this contract, the Contractor warrants that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, workmanship, or design furnished, or performed by the Contractor or any subcontractor or supplier at any tier.

**b.** This warranty shall continue for a period of one year from the date of final acceptance of the work, except as noted. If the Owner takes possession of any part of the work before final acceptance, this warranty shall continue for a period of one year from the date the Owner takes possession. However, this will not relieve the Contractor from corrective items required by the final acceptance of the project work. Light Emitting Diode emitting diode (LED) light fixtures with the exception of obstruction lighting, must be warranted by the manufacturer for a minimum of four (4) years after date of installation inclusive of all electronics.

**c.** The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Owner real or personal property, when that damage is the result of the Contractor's failure to conform to contract requirements; or any defect of equipment, material, workmanship, or design furnished by the Contractor.

**d.** The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for one year from the date of repair or replacement.

**e.** The Owner will notify the Contractor, in writing, within seven (7) days after the discovery of any failure, defect, or damage.

**f.** If the Contractor fails to remedy any failure, defect, or damage within 14 days after receipt of notice, the Owner shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

**g.** With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall: (1) Obtain all warranties that would be given in normal commercial practice; (2) Require all warranties to be executed, in writing, for the benefit of the Owner, as directed by the Owner, and (3) Enforce all warranties for the benefit of the Owner.

**h.** This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.

**90-11 Contractor Final Project Documentation.** Approval of final payment to the Contractor is contingent upon completion and submittal of the items listed below. The final payment will not be approved until the RPR approves the Contractor's final submittal. The Contractor shall:

**a.** Provide two (2) copies of all manufacturers warranties specified for materials, equipment, and installations.

**b.** Provide weekly payroll records (not previously received) from the general Contractor and all subcontractors.

**c.** Complete final cleanup in accordance with Section 40, paragraph 40-08, *Final Cleanup*.

**d.** Complete all punch list items identified during the Final Inspection.

**e.** Provide complete release of all claims for labor and material arising out of the Contract.

**f.** Provide a certified statement signed by the subcontractors, indicating actual amounts paid to the Disadvantaged Business Enterprise (DBE) subcontractors and/or suppliers associated with the project.

**g.** When applicable per state requirements, return copies of sales tax completion forms.

**h.** Manufacturer's certifications for all items incorporated in the work.

**i.** All required record drawings, as-built drawings or as-constructed drawings.

**j.** Project Operation and Maintenance (O&M) Manual(s).

**k.** Security for Construction Warranty.

**l.** Equipment commissioning documentation submitted, if required.

## **END OF SECTION 90**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 90 MEASUREMENT AND PAYMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
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### **Item C-100 Contractor Quality Control Program (CQCP)**

**100-1 General.** Quality is more than test results. Quality is the combination of proper materials, testing, workmanship, equipment, inspection, and documentation of the project. Establishing and maintaining a culture of quality is key to achieving a quality project. The Contractor shall establish, provide, and maintain an effective Contractor Quality Control Program (CQCP) that details the methods and procedures that will be taken to assure that all materials and completed construction required by this contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified here and elsewhere in the contract technical specifications, the Contractor shall assume full responsibility for accomplishing the stated purpose.

The Contractor shall establish a CQCP that will:

- a. Provide qualified personnel to develop and implement the CQCP.
- b. Provide for the production of acceptable quality materials.
- c. Provide sufficient information to assure that the specification requirements can be met.
- d. Document the CQCP process.

The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the CQCP has been reviewed and approved by the DEN Project Manager (DEN PM). No partial payment will be made for materials subject to specific quality control (QC) requirements until the CQCP has been reviewed and approved.

The QC requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the quality assurance (QA) testing requirements. QA testing requirements are the responsibility of the DEN PM or Contractor as specified in the specifications.

A Quality Control (QC)/Quality Assurance (QA) workshop with the Engineer, DEN PM, Contractor, subcontractors, testing laboratories, and Owner's representative must be held prior to start of construction. The QC/QA workshop will be facilitated by the Contractor. The Contractor shall coordinate with the Airport and the DEN PM on time and location of the QC/QA workshop. Items to be addressed, at a minimum, will include:

- a. Review of the CQCP including submittals, QC Testing, Action & Suspension Limits for Production, Corrective Action Plans, Distribution of QC reports, and Control Charts.
- b. Discussion of the QA program.
- c. Discussion of the QC and QA Organization and authority including coordination and information exchange between QC and QA.
- d. Establish regular meetings to discuss control of materials, methods and testing.
- e. Establishment of the overall QC culture.

**100-2 Description of program.**

**a. General description.** The Contractor shall establish a CQCP to perform QC inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors. The CQCP shall ensure conformance to applicable specifications and plans with respect to materials, off-site fabrication, workmanship, construction, finish, and functional performance. The CQCP shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of QC.

**b. Contractor Quality Control Program (CQCP).** The Contractor shall describe the CQCP in a written document that shall be reviewed and approved by the DEN PM prior to the start of any production, construction, or off-site fabrication. The written CQCP shall be submitted to the DEN PM for review and approval at least 10 calendar days before the CQCP Workshop. The Contractor's CQCP and QC testing laboratory must be approved in writing by the DEN PM prior to the Notice to Proceed (NTP).

The CQCP shall be organized to address, as a minimum, the following:

1. QC organization and resumes of key staff
2. Project progress schedule
3. Submittals schedule
4. Inspection requirements
5. QC testing plan
6. Documentation of QC activities and distribution of QC reports
7. Requirements for corrective action when QC and/or QA acceptance criteria are not met
8. Material quality and construction means and methods. Address all elements applicable to the project that affect the quality of the pavement structure including subgrade, subbase, base, and surface course. Some elements that must be addressed include, but is not limited to mix design, aggregate grading, stockpile management, mixing and transporting, placing and finishing, quality control testing and inspection, smoothness, laydown plan, equipment, and temperature management plan.

The Contractor must add any additional elements to the CQCP that is necessary to adequately control all production and/or construction processes required by this contract.

**100-3 CQCP organization.** The CQCP shall be implemented by the establishment of a QC organization. An organizational chart shall be developed to show all QC personnel, their authority, and how these personnel integrate with other management/production and construction functions and personnel.

The organizational chart shall identify all QC staff by name and function, and shall indicate the total staff required to implement all elements of the CQCP, including inspection and testing for each item of work. If necessary, different technicians can be used for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the CQCP, the personnel assigned shall be subject to the qualification requirements of paragraphs 100-03a and 100-03b. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

The QC organization shall, as a minimum, consist of the following personnel:

**a. Program Administrator.** The Contractor Quality Control Program Administrator (CQCPA) must be a full-time employee of the Contractor, or a consultant engaged by the Contractor. The CQCPA must have a minimum of five (5) years of experience in QC pavement construction with prior QC experience on a project of comparable size and scope as the contract.

Included in the five (5) years of paving/QC experience, the CQCPA must meet at least one of the following requirements:

- (1) Professional Engineer with one (1) year of airport paving experience.
- (2) Engineer-in-training with two (2) years of airport paving experience.
- (3) National Institute for Certification in Engineering Technologies (NICET) Civil Engineering Technology Level IV with three (3) years of airport paving experience.
- (4) An individual with four (4) years of airport paving experience, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

The CQCPA must have full authority to institute any and all actions necessary for the successful implementation of the CQCP to ensure compliance with the contract plans and technical specifications. The CQCPA authority must include the ability to immediately stop production until materials and/or processes are in compliance with contract specifications. The CQCPA must report directly to a principal officer of the construction firm. The CQCPA may supervise the Quality Control Program on more than one project provided that person can be at the job site within two (2) hours after being notified of a problem.

**b. QC technicians.** A sufficient number of QC technicians necessary to adequately implement the CQCP must be provided. These personnel must be either Engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field equivalent to NICET Level II in Civil Engineering Technology or higher, and shall have a minimum of two (2) years of experience in their area of expertise.

The QC technicians must report directly to the CQCPA and shall perform the following functions:

- (1) Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by paragraph 100-6.
- (2) Performance of all QC tests as required by the technical specifications and paragraph 100-8.
- (3) Performance of tests for the DEN PM when required by the technical specifications.

Certification at an equivalent level of qualification and experience by a state or nationally recognized organization will be acceptable in lieu of NICET certification.

**c. Staffing levels.** The Contractor shall provide sufficient qualified QC personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The CQCP shall state where different technicians will be required for different work elements.

**100-4 Project progress schedule.** Critical QC activities must be shown on the project schedule as required by Section 80, paragraph 80-03, *Execution and Progress*.

**100-5 Submittals schedule.** The Contractor shall submit a detailed listing of all submittals (for example, mix designs, material certifications) and shop drawings required by the technical specifications. The listing can be developed in a spreadsheet format and shall include as a minimum:

- a. Specification item number
- b. Item description
- c. Description of submittal
- d. Specification paragraph requiring submittal
- e. Scheduled date of submittal

**100-6 Inspection requirements.** QC inspection functions shall be organized to provide inspections for all definable features of work, as detailed below. All inspections shall be documented by the Contractor as specified by paragraph 100-9.

Inspections shall be performed as needed to ensure continuing compliance with contract requirements until completion of the particular feature of work. Inspections shall include the following minimum requirements:

a. During plant operation for material production, QC test results and periodic inspections shall be used to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment used in proportioning and mixing shall be inspected to ensure its proper operating condition. The CQCP shall detail how these and other QC functions will be accomplished and used.

b. During field operations, QC test results and periodic inspections shall be used to ensure the quality of all materials and workmanship. All equipment used in placing, finishing, and compacting shall be inspected to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The CQCP shall document how these and other QC functions will be accomplished and used.

**100-7 Contractor QC testing facility.**

a. For projects that include Item P-401, Item P-403, and Item P-404, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM D3666, *Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials*:

- 8.1.3 Equipment Calibration and Checks;
- 8.1.9 Equipment Calibration, Standardization, and Check Records;
- 8.1.12 Test Methods and Procedures

b. For projects that include P-501, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM C1077, *Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation*:

- 7 Test Methods and Procedures
- 8 Facilities, Equipment, and Supplemental Procedures

**100-8 QC testing plan.** As a part of the overall CQCP, the Contractor shall implement a QC testing plan, as required by the technical specifications. The testing plan shall include the minimum tests and test frequencies required by each technical specification Item, as well as any additional QC tests that the Contractor deems necessary to adequately control production and/or construction processes.

The QC testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:

- a. Specification item number (e.g., P-401)
- b. Item description (e.g., Hot Mix Asphalt Pavements)
- c. Test type (e.g., gradation, grade, asphalt content)
- d. Test standard (e.g., ASTM or American Association of State Highway and Transportation Officials (AASHTO) test number, as applicable)
- e. Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated)
- f. Responsibility (e.g., plant technician)
- g. Control requirements (e.g., target, permissible deviations)

The QC testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D3665. The DEN PM shall be provided the opportunity to witness QC sampling and testing.

All QC test results shall be documented by the Contractor as required by paragraph 100-9.

**100-9 Documentation.** The Contractor shall maintain current QC records of all inspections and tests performed. These records shall include factual evidence that the required QC inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.

These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the terms of the contract. Legible copies of these records shall be furnished to the DEN PM daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the CQCPA.

Contractor QC records required for the contract shall include, but are not necessarily limited to, the following records:

**a. Daily inspection reports.** Each Contractor QC technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations. These technician's daily reports shall provide factual evidence that continuous QC inspections have been performed and shall, as a minimum, include the following:

- (1) Technical specification item number and description
- (2) Compliance with approved submittals
- (3) Proper storage of materials and equipment
- (4) Proper operation of all equipment
- (5) Adherence to plans and technical specifications
- (6) Summary of any necessary corrective actions

- (7) Safety inspection.
- (8) Photographs and/or video

The daily inspection reports shall identify all QC inspections and QC tests conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

The daily inspection reports shall be signed by the responsible QC technician and the CQCPA. The DEN PM shall be provided at least one copy of each daily inspection report on the work day following the day of record. When QC inspection and test results are recorded and transmitted electronically, the results must be archived.

**b. Daily test reports.** The Contractor shall be responsible for establishing a system that will record all QC test results. Daily test reports shall document the following information:

- (1) Technical specification item number and description
- (2) Test designation
- (3) Location
- (4) Date of test
- (5) Control requirements
- (6) Test results
- (7) Causes for rejection
- (8) Recommended remedial actions
- (9) Retests

Test results from each day's work period shall be submitted to the DEN PM prior to the start of the next day's work period. When required by the technical specifications, the Contractor shall maintain statistical QC charts. When QC daily test results are recorded and transmitted electronically, the results must be archived.

**100-10 Corrective action requirements.** The CQCP shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process into control. The requirements for corrective action shall include both general requirements for operation of the CQCP as a whole, and for individual items of work contained in the technical specifications.

The CQCP shall detail how the results of QC inspections and tests will be used for determining the need for corrective action and shall contain clear rules to gauge when a process is out of control and the type of correction to be taken to regain process control.

When applicable or required by the technical specifications, the Contractor shall establish and use statistical QC charts for individual QC tests. The requirements for corrective action shall be linked to the control charts.

**100-11 Inspection and/or observations by the DEN PM.** All items of material and equipment are subject to inspection and/or observation by the DEN PM at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate QC system in conformance with the requirements detailed here and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place shall be subject to inspection and/or observation by the DEN PM at the site for the same purpose.

Inspection and/or observations by the DEN PM does not relieve the Contractor of performing QC inspections of either on-site or off-site Contractor's or subcontractor's work.

**100-12 Noncompliance.**

a. The Resident Project Representative (DEN PM) will provide written notice to the Contractor of any noncompliance with their CQCP. After receipt of such notice, the Contractor must take corrective action.

b. When QC activities do not comply with either the CQCP or the contract provisions or when the Contractor fails to properly operate and maintain an effective CQCP, and no effective corrective actions have been taken after notification of non-compliance, the DEN PM will recommend the Owner take the following actions:

- (1) Order the Contractor to replace ineffective or unqualified QC personnel or subcontractors and/or
- (2) Order the Contractor to stop operations until appropriate corrective actions are taken.

**METHOD OF MEASUREMENT**

**100-13 Basis of measurement and payment.** Contractor Quality Control Program (CQCP) is for the personnel, tests, facilities and documentation required to implement the CQCP. The CQCP will be paid as a lump sum with the following schedule of partial payments:

- a. With first pay request, 25% with approval of CQCP and completion of the Quality Control (QC)/Quality Assurance (QA) workshop.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 20%.
- d. When 75% or more of the original contract is earned, an additional 20%
- e. After final inspection and acceptance of project, the final 10%.

**BASIS OF PAYMENT**

**100-14 Payment will be made under:**

Item C-100-14.1 Contractor Quality Control Program (CQCP) – per lump sum

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

National Institute for Certification in Engineering Technologies (NICET)

ASTM International (ASTM)

ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D3665	Standard Practice for Random Sampling of Construction Materials

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM C-100 CONTRACTOR QUALITY CONTROL PROGRAM (CQCP)**

**DENVER INTERNATIONAL AIRPORT**  
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ASTM D3666

Standard Specification for Minimum Requirements for Agencies  
Testing and Inspecting Road and Paving Materials

**END OF ITEM C-100**

### Item C-105 Mobilization

**105-1 Description.** This item of work shall consist of, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project except as provided in the contract as separate pay items.

**105-2 Mobilization limit.** Mobilization shall be limited to 5 percent of the total project cost.

**105-3 Posted notices.** Prior to commencement of construction activities, the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor: Equal Employment Opportunity (EEO) Poster “Equal Employment Opportunity is the Law” in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL “Notice to All Employees” Poster; and Applicable Davis-Bacon Wage Rate Determination. These notices must remain posted until final acceptance of the work by the Owner.

### METHOD OF MEASUREMENT

**105-5 Basis of measurement and payment.** Based upon the contract lump sum price for “Mobilization” partial payments will be allowed as follows:

- a. With first pay request, 25%.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 40%.
- d. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation*, the final 10%.

### BASIS OF PAYMENT

**105-6 Payment will be made under:**

Item C-105-6.1	Mobilization – per lump sum
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### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Office of Federal Contract Compliance Programs (OFCCP)

Executive Order 11246, as amended

EEOC-P/E-1 – Equal Employment Opportunity is the Law Poster

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM C-105 MOBILIZATION**

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United States Department of Labor, Wage and Hour Division (WHD)

WH 1321 – Employee Rights under the Davis-Bacon Act Poster

**END OF ITEM C-105**

### Item C-110 Method of Estimating Percentage of Material Within Specification Limits (PWL)

**110-1 General.** When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (PWL), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average ( $\bar{X}$ ) and sample standard deviation ( $S_n$ ) of the specified number ( $n$ ) of sublots for the lot and the specification tolerance limits,  $L$  for lower and  $U$  for upper, for the particular acceptance parameter. From these values, the respective Quality index,  $Q_L$  for Lower Quality Index and/or  $Q_U$  for Upper Quality Index, is computed and the PWL for the lot for the specified  $n$  is determined from Table 1. All specification limits specified in the technical sections shall be absolute values. Test results used in the calculations shall be to the significant figure given in the test procedure.

There is some degree of uncertainty (risk) in the measurement for acceptance because only a small fraction of production material (the population) is sampled and tested. This uncertainty exists because all portions of the production material have the same probability to be randomly sampled. The Contractor's risk is the probability that material produced at the acceptable quality level is rejected or subjected to a pay adjustment. The Owner's risk is the probability that material produced at the rejectable quality level is accepted.

It is the intent of this section to inform the Contractor that, in order to consistently offset the Contractor's risk for material evaluated, production quality (using population average and population standard deviation) must be maintained at the acceptable quality specified or higher. In all cases, it is the responsibility of the Contractor to produce at quality levels that will meet the specified acceptance criteria when sampled and tested at the frequencies specified.

**110-2 Method for computing PWL.** The computational sequence for computing PWL is as follows:

- a. Divide the lot into  $n$  sublots in accordance with the acceptance requirements of the specification.
- b. Locate the random sampling position within the subplot in accordance with the requirements of the specification.
- c. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.
- d. Find the sample average ( $\bar{X}$ ) for all subplot test values within the lot by using the following formula:

$$\bar{X} = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where:  $\bar{X}$  = Sample average of all subplot test values within a lot

$x_1, x_2, \dots, x_n$  = Individual subplot test values

$n$  = Number of subplot test values

- e. Find the sample standard deviation ( $S_n$ ) by use of the following formula:

$$S_n = [(d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2)/(n-1)]^{1/2}$$

Where:  $S_n$  = Sample standard deviation of the number of subplot test values in the set  
 $d_1, d_2, \dots, d_n$  = Deviations of the individual subplot test values  $x_1, x_2, \dots$  from the average value  $X$

that is:  $d_1 = (x_1 - X), d_2 = (x_2 - X) \dots d_n = (x_n - X)$

$n$  = Number of subplot test values

f. For single sided specification limits (i.e., L only), compute the Lower Quality Index  $Q_L$  by use of the following formula:

$$Q_L = (X - L) / S_n$$

Where: L = specification lower tolerance limit

Estimate the percentage of material within limits (PWL) by entering Table 1 with  $Q_L$ , using the column appropriate to the total number ( $n$ ) of measurements. If the value of  $Q_L$  falls between values shown on the table, use the next higher value of PWL.

g. For double-sided specification limits (i.e., L and U), compute the Quality Indexes  $Q_L$  and  $Q_U$  by use of the following formulas:

$$Q_L = (X - L) / S_n$$

and

$$Q_U = (U - X) / S_n$$

Where: L and U = specification lower and upper tolerance limits

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table 1 separately with  $Q_L$  and  $Q_U$ , using the column appropriate to the total number ( $n$ ) of measurements, and determining the percent of material above  $P_L$  and percent of material below  $P_U$  for each tolerance limit. If the values of  $Q_L$  fall between values shown on the table, use the next higher value of  $P_L$  or  $P_U$ . Determine the PWL by use of the following formula:

$$PWL = (P_U + P_L) - 100$$

Where:  $P_L$  = percent within lower specification limit

$P_U$  = percent within upper specification limit

### EXAMPLE OF PWL CALCULATION

**Project:** Example Project

**Test Item:** Item P-401, Lot A.

#### A. PWL Determination for Mat Density.

1. Density of four random cores taken from Lot A.

A-1 = 96.60

A-2 = 97.55

A-3 = 99.30

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM C-110 METHOD OF ESTIMATING PERCENTAGE**  
**OF MATERIAL WITHIN SPECIFICATION LIMITS (PWL)**


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$$A-4 = 98.35$$

$$n = 4$$

2. Calculate average density for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$$

$$X = 97.95\% \text{ density}$$

3. Calculate the standard deviation for the lot.

$$S_n = [((96.60 - 97.95)^2 + (97.55 - 97.95)^2 + (99.30 - 97.95)^2 + (98.35 - 97.95)^2) / (4 - 1)]^{1/2}$$

$$S_n = [(1.82 + 0.16 + 1.82 + 0.16) / 3]^{1/2}$$

$$S_n = 1.15$$

4. Calculate the Lower Quality Index  $Q_L$  for the lot. ( $L=96.3$ )

$$Q_L = (X - L) / S_n$$

$$Q_L = (97.95 - 96.30) / 1.15$$

$$Q_L = 1.4348$$

5. Determine PWL by entering Table 1 with  $Q_L = 1.44$  and  $n = 4$ .

$$PWL = 98$$

**B. PWL Determination for Air Voids.**

1. Air Voids of four random samples taken from Lot A.

$$A-1 = 5.00$$

$$A-2 = 3.74$$

$$A-3 = 2.30$$

$$A-4 = 3.25$$

2. Calculate the average air voids for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$

$$X = 3.57\%$$

3. Calculate the standard deviation  $S_n$  for the lot.

$$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$$

$$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$$

$$S_n = 1.12$$

4. Calculate the Lower Quality Index  $Q_L$  for the lot. ( $L = 2.0$ )

$$Q_L = (X - L) / S_n$$

$$Q_L = (3.57 - 2.00) / 1.12$$

$$Q_L = 1.3992$$

5. Determine  $P_L$  by entering Table 1 with  $Q_L = 1.41$  and  $n = 4$ .

$$P_L = 97$$

6. Calculate the Upper Quality Index  $Q_U$  for the lot. ( $U = 5.0$ )

$$Q_U = (U - X) / S_n$$

$$Q_U = (5.00 - 3.57) / 1.12$$

$$Q_U = 1.2702$$

7. Determine  $P_U$  by entering Table 1 with  $Q_U = 1.29$  and  $n = 4$ .

$$P_U = 93$$

8. Calculate Air Voids PWL

$$PWL = (P_L + P_U) - 100$$

$$PWL = (97 + 93) - 100 = 90$$

### EXAMPLE OF OUTLIER CALCULATION (REFERENCE ASTM E178)

**Project:** Example Project

**Test Item:** Item P-401, Lot A.

#### A. Outlier Determination for Mat Density.

1. Density of four random cores taken from Lot A arranged in descending order.

$$A-3 = 99.30$$

$$A-4 = 98.35$$

$$A-2 = 97.55$$

$$A-1 = 96.60$$

2. From ASTM E178, Table 1, for  $n=4$  an upper 5% significance level, the critical value for test criterion = 1.463.

3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

- a. For measurements greater than the average:

If (measurement - average)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-3, check if  $(99.30 - 97.95) / 1.15$  is greater than 1.463.

Since 1.174 is less than 1.463, the value is not an outlier.

- b. For measurements less than the average:

If (average - measurement)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-1, check if  $(97.95 - 96.60) / 1.15$  is greater than 1.463.

Since 1.435 is less than 1.463, the value is not an outlier.

**Note:** In this example, a measurement would be considered an outlier if the density were:

$$\text{Greater than } (97.95 + 1.463 \times 1.15) = 99.63\%$$

OR

$$\text{less than } (97.95 - 1.463 \times 1.15) = 96.27\%.$$

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**Table 1. Table for Estimating Percent of Lot Within Limits (PWL)**

Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Positive Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4717	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1192	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9671	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5582	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4355	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4030	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0793	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Negative Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4355	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5582	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

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## **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM E178 Standard Practice for Dealing with Outlying Observations

**END OF ITEM C-110**

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## **Item P-101 Preparation/Removal of Existing Pavements**

### **DESCRIPTION**

**101-1** This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

### **EQUIPMENT AND MATERIALS**

**101-2** All equipment and materials shall be specified here and in the following paragraphs or approved by the DEN Project Manager (DEN PM). The equipment shall not cause damage to the pavement to remain in place.

### **CONSTRUCTION**

#### **101-3.1 Removal of existing pavement.**

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

**a. Concrete pavement removal.** When it is necessary to remove existing concrete pavement and leave adjacent concrete in place the joint between the removal area and adjoining pavement to stay in place shall first be cut full depth with a standard diamond-type concrete saw. Next, a full depth saw cut shall be made parallel to the joint at least 24 inches from the joint and at least 12 inches from the end of any dowels. All pavements between this last saw cut and the joint line shall be carefully broken up and removed using hand-held jackhammers, 30 lb. or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. The joint face shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2-inch and no gradual offset greater than 1 inch when tested in a horizontal direction with a 12 ft. straightedge. Sawcutting depth may vary nominally and no extra payment will be allotted for varying depths.

The Contractor shall remove the remaining portion of concrete pavement slab by lifting and placing directly into haul trucks. The Contractor will not be allowed to use hydraulic rams on excavators that may damage the cement treated base below the pavement to be removed in areas where demolition consists of slab removal only.

An alternative removal method may be accepted by the DEN PM if the Contractor can demonstrate to the DEN PM successful removal without damage to adjacent concrete or base material below. If during subsequent removals it is found the method is causing damage to the adjacent panels or base material below, the Contractor's method shall be rejected by the DEN PM and the DEN PM shall direct the Contractor to begin using the method above.

The Contractor's removal operation shall not cause damage to cables, utility ducts, pipelines, or drainage structures under the pavement. Concrete slabs that are damaged by under breaking shall be removed. Any damage shall be repaired at the Contractor's expense.

**(1) Edge Repair.** The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas which are damaged during construction shall be repaired at no cost to the Owner; repair of previously existing damage areas will be paid for as listed in the bid schedule.

**(2) Underbreak Repair.** Any under breaking of slabs that are to remain in-place shall result in the entire slab removal and replacement at the Contractor's expense to the next joint.

**(3) Underlying Material.** The underlying material adjacent to the edge of and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete and shall be shaped as shown on the plans or as directed. Sufficient material shall be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement which is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction, shall be carefully removed and replaced with concrete. The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed. If the disturbed material causes under breaking of concrete panels that are to remain in-place, it shall result in the entire slab removal and replacement at the Contractor's expense to the next joint.

**b. Existing Asphalt Pavement Removal and Repair by Milling.** This item shall consist of milling existing bituminous concrete pavement to allow for placement of sufficient thickness of bituminous concrete overlay for pavement repairs or construction on the runway or taxiway shoulders.

The vertical edges of the milled surface shall be sawcut to expose a clean true vertical edge to pave against.

All operations shall be carefully controlled to prevent damage to the asphalt pavement and to the underlying material to remain in place.

**c. Existing Full Depth Asphalt Pavement Removal.** This item shall consist of sawcutting and removal of existing bituminous concrete pavement (including Asphalt Treated Permeable Base (ATPB)) to allow for replacement of P-501 slabs along the edges adjacent to asphalt shoulders. A standard diamond-type concrete saw shall be used to make the sawcut the full depth of the asphalt pavement (including ATPB). The pavement shall be removed so the joint for each layer of pavement replacement is offset 1 foot from the joint in the preceding layer. This does not apply if the removed pavement is to be replaced with concrete or soil.

The edge of existing bituminous concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas which are damaged during construction shall be repaired at no cost to the Owner.

All operations shall be carefully controlled to prevent damage to the asphalt pavement and to the underlying material to remain in place.

**101-3.2 Preparation of joints and cracks prior to overlay/surface treatment.** Remove all vegetation and debris from cracks to a minimum depth of 1 inch (25 mm). If extensive vegetation exists, treat the specific area with a concentrated solution of a water-based herbicide approved by the DEN PM. Fill all cracks greater than 1/4 inch (6 mm) wide) with a crack sealant per ASTM D6690. The crack sealant, preparation, and application shall be compatible with the

surface treatment/overlay to be used. To minimize contamination of the asphalt with the crack sealant, underfill the crack sealant a minimum of 1/8 inch (3 mm), not to exceed ¼ inch (6 mm). Any excess joint or crack sealer shall be removed from the pavement surface.

**101-3.3 Removal of Foreign Substances/contaminates prior to remarking.** Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as directed by the DEN PM in the field during construction.

High-pressure water and rotary grinding may be used. If chemicals are used, they shall comply with the state's environmental protection regulations. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch (3 mm) deep. If it is deemed by the DEN PM that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as directed by the DEN PM.

The water blasting equipment shall be truck mounted and shall be capable of water pressures of 2,000 to 40,000 psi. The equipment shall be capable of adjusting the pressure to accomplish paint or cure removal without damaging the paving surface. The equipment shall be capable of following a straight line and be maneuverable to accommodate various pavement markings. The spray width needs to be able to accommodate lines 6" and wider. If water blasting is used to remove lines on active airfield pavements, a vacuum system will be provided to allow for timely repainting and the prevention of any debris being ingested into propellers or turbine engines once the water blasting equipment has exited the active pavements.

If required on asphalt pavement, the grinding equipment shall be capable of adjusting the height to accomplish paint removal with only lightly scaring, but not damaging the paving surface. The equipment shall be capable of following a straight line and be maneuverable to accommodate various pavement markings. A vacuum truck shall be used to immediately clean up all debris created by the removal process.

Removal of foreign substances shall not proceed until approved by the DEN PM. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans or disposed off-site legally.

**101-3.4 Concrete spall or failed asphaltic concrete pavement repair.**

**a. Spall Repair.** Spalls shall be repaired where indicated and where directed. Repair materials and procedures shall be completed as required in Item P-501.

**101-3.5 Cold milling.** Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The vertical edges of the milled surface shall be sawcut to expose a clean true vertical edge to pave against. The milling machine or grinder shall operate without tearing or gouging the underlying surface. The milling machine or grinder shall be equipped with grade and slope controls, and a positive means of dust control. All millings shall be removed and disposed in areas designated on the plans. If the Contractor mills or grinds deeper or wider than the plans specify, the Contractor shall replace the material removed with new material at the Contractor's Expense.

**a. Patching.** The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of

controlling the depth of cut. The DEN PM shall layout the area to be milled with a straightedge in increments of 1-foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn't have the appropriate milling machine, or areas that are damaged because of his negligence, shall be repaired by the Contractor at the Contractor's Expense.

**b. Profiling, grade correction, or surface correction.** The milling machine shall have a minimum width of 7 feet and it shall be equipped with electronic grade control devices that will cut the surface to the grade specified. The tolerances shall be maintained within +0 inch and -1/4 inch (+0 mm and -6mm) of the specified grade. The machine must cut vertical edges and have a positive method of dust control. The machine must have the ability to remove the millings or cuttings from the pavement and load them into a truck. All millings shall be removed and disposed of in areas designated on the plans.

**c. Clean-up.** The Contractor shall sweep the milled surface daily and immediately after the milling until all residual materials are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove loose residual material. Waste materials shall be collected and removed from the pavement surface and adjacent areas by sweeping or vacuuming. Waste materials shall be removed and disposed in areas designated on the plans.

**101-3.6. Preparation of asphalt pavement surfaces prior to surface treatment.** Existing asphalt pavements to be treated with a surface treatment shall be prepared as follows:

**a.** Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt pavement similar to that of the existing pavement in accordance with paragraph 101-3.4b.

**b.** Repair joints and cracks in accordance with paragraph 101-3.2.

**c.** Remove oil or grease that has not penetrated the asphalt pavement by scrubbing with a detergent and washing thoroughly with clean water. After cleaning, treat these areas with an oil spot primer.

**d.** Clean pavement surface immediately prior to placing the surface treatment so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film.

**101-3.7 Maintenance.** The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the DEN PM. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor's expense.

**101-3.8 Preparation of Joints in Rigid Pavement prior to resealing.** Not used.

**101-3.8.1 Removal of Existing Joint Sealant.** Not used.

**101-3.8.2 Cleaning prior to sealing.** Not used.

**101-3.8.3 Joint sealant.** Not used..

**101-3.9 Preparation of Cracks in Flexible Pavement prior to sealing.** Not used.

**101-3.9.1 Preparation of Crack.** Not used.

**101-3.9.2 Removal of Existing Crack Sealant.** Not used.

**101-3.9.3 Crack Sealant.** Not used,

**101-3.9.4 Removal of Pipe and other Buried Structures.**

**a. Removal of Existing Pipe Material.** Contractor is responsible to contact the owner as to the status of the pipeline. If pipelines have been abandoned in-place by the pipeline owners, the pipelines may not have been purged or cleaned and may contain petroleum products. The contractor shall exercise extreme care in removing these facilities and is responsible for removing the pipe including any remaining contents, irrespective of the current pipe conditions. The Contractor should also expect to find other pipelines, etc. which have been abandoned by unknown owners during the 15 to 20-year life of the oil and gas fields. Contract documents indicate the general location of known pipelines and developed utilities. All pipelines shown on the plans shall be located by Contractor by potholing to verify location, depth, and usage. The Contractor shall remove all utility pipes and lines included in the earthwork contract area in accordance with these specifications. All buried pipelines, utilities, buried tanks, and any other structures within the construction area of all runways, taxiways and aprons extending to 10 feet (3 m) outside the limits of construction shall be removed. The Contractor shall notify oil and gas facility owners and the DEN Project Manager in writing 30 days in advance of requiring work in areas currently occupied by oil and gas wells and buried pipelines.

The ends of any pipelines left in place shall have the ends capped prior to burial, according to applicable Federal Department of Transportation Regulations. Any piping which is left in place shall be surveyed and the coordinates of the ends of the abandoned pipe (or other items left in place) shall be provided to the DEN Project Manager and included on the "as-built" drawings."

Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off-site in a timely manner following removal. Trenches shall be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 95% of ASTM D1557.

**b. Removal of Inlets/Manholes.** Where indicated on the plans or as directed by the DEN PM, inlets, and/or manholes shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas cohesive soil must be compacted to 95% of ASTM D1557, when outside of paved areas cohesive soil must be compacted to 95% of ASTM D698.

**c. Removal of Electrical.** The Contractor shall remove all abandoned cable, cable identified to be removed, ductwork, base cans including concrete encasement and all light fixtures, signs, electrical ground wells, and duct markers within the construction limits of taxiway and runway pavements to be removed, widened or constructed, or as shown on the Plans. Protect existing airfield lighting fixtures and base plates from damage and deliver them to the Airport for storage as directed by the DEN Project Manager. Discard all base cans, conduit, transformers and cable off-site. The Electrical Contractor shall provide written documentation to the DEN Project Manager that electrical cable has been removed prior to slab sawcutting and demolition.

**d. Foundations and Slabs on Grade.** Where indicated on the Plans or as directed by the DEN PM, all structures at or above grade and within 10 feet horizontally of the construction limits shall be removed.

**e. Removal of Oil/Water Separator Tank.** Contractor shall remove 50,000 gallon steel oil/water separator tank that is approximately 12 feet in diameter and 59 feet long.

**f. Removal of Existing Riprap.** Remove and dispose of the existing riprap section, including and base or fabric material, Dispose of non-aggregate material off site and dispose of rock and any other soil associated with said removal as directed by the DEN PM.

**g. Removal of Water Quality Structure.** The Contractor shall remove water quality concrete structure, including separate water quality inlet, and backfill as applicable to create required foundational material for new facilities being constructed in this place, per demolition Plans and/or as directed by the DEN PM. Contractor shall be responsible for any removal, hauling and disposal fees.

**h. Removal of High Mast Lighting.** The Contractor shall remove existing apron mast lighting, above grade pullbox, adjacent bollards and foundations as depicted on the Plans without damaging any of the poles or fixtures. Return material to a DEN location as directed by the DEN PM.

**i. Removal of Existing Engine Block Heater Rack.** Remove and salvage engine block heater rack as depicted on the Plans. Return material to a DEN location as directed by the DEN PM.

**j. Remove Underdrain Pipe and Cleanouts.** Remove as depicted on the Plans and backfill in accordance with Item P-152 and/or typical sections, whichever are applicable.

**k. Removal of Headwall, Wingwalls and End Sections.** Remove as depicted on the Plans and dispose of at a DEN location as directed by the DEN PM.

**l. Removal of DIW Force Main.** Contractor shall coordinate depressurization of DIW Force Main with DEN PM and applicable DEN personnel prior to commencement of this demolition activity. Materials removed shall be disposed of off-site and excavation backfilled in accordance with Item P-152, applicable typical sections and/or directed by the DEN PM.

### **METHOD OF MEASUREMENT**

**101-4.1 Lump sum items.** Items indicated as lump sum will be paid at the agreed upon bid lump sum price in partial payments based on a schedule of values determined by the DEN PM.

**101-4.2 Pavement removal.** The unit of measurement for pavement removal shall be the number of square yards removed by the Contractor and accepted by the DEN PM. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to pavement removal. Dowel bar and bond breaker removal shall be incidental to pavement removal.

Pavement removal indicated as “Full Depth” includes the removal of all structural layers below the top pavement surface. Any soil cement removed outside of the designed limits of removal because the soil-cement or aggregate-cement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment.

Pavement removal indicated as “Slab Only” includes the top rigid pavement layer only. Any removal of structural layers below the top pavement surface will be considered outside of the designed limits of removal by negligence on the part of the Contractor. Damaged structural layers shall be repaired by the Contractor at no cost to the owner and shall not be measured for payment.

The thickness of the existing material to be removed is approximate only and the Contractor will not be reimbursed for areas that may be thicker than shown on the plans. Removal of pavement shall include all sawcutting, excavation, hauling, and disposal (including disposal fees) of materials to facilitate removal.

**101-4.3 Cold milling.** The unit of measure for cold milling shall be per square yard. The location and average depth of the cold milling shall be as shown on the Plans. If the initial cut does not correct the condition, the Contractor shall re-mill the area and will be paid for the total depth of milling indicated.

**101-4.4 Removal of Pipe.** The length of pipe to be removed shall be measured in its original position along the centerline of the pipe from end or inside faced of the structure(s) or end of pipe with no structure present. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**101-4.5 Removal of Buried Structures.** The unit of measurement for buried structures, such as the oil/water separator tank, water quality structure, ground well and flared end section, will be per each. Other work required, such as off-site disposal and backfilling, shall be considered as a subsidiary obligation of the Contractor and covered under the bid item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**101-4.6– Remove Underdrain Cleanout.** Measurement for payment for the removal of existing underdrain cleanouts and associated pipe and fittings shall be made per each. Any pipe removed outside the preapproved limits of removal because the pipe was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. The removal of underdrain cleanouts shall include concrete, reinforcing, and capping the end of the existing underdrain to remain. The remains shall be disposed of off-site.

**101-4.7 – Removal of Manholes.** Measurement for payment of the removal of existing manholes and associated pipe and fittings shall be made per each. Any pipe removed outside the preapproved limits of removal because the pipe was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. The removal of underdrain manholes shall include concrete, reinforcing, and capping the end of the existing pipe to remain. The removed material shall be disposed of off-site.

**101-4.8 - Remove Underdrain Pipe (Complete).** Measurement for payment for removal of existing underdrain pipe and associated fittings shall be made per linear foot. Any pipe removed outside the preapproved limits of removal because the pipe was damaged due to negligence on the part of the Contractor shall not be included in the measurement for payment. The removal of underdrains shall include piping, porous backfill, filter fabric, concrete and capping the end of the existing underdrain to remain. Removed material shall be disposed of off-site.

**101-4.9 - Remove Underdrain Cleanout (Complete).** Measurement for payment of the removal of underdrain cleanouts and associated fittings, components including encasement material shall be made per each. Any pipe removed outside the preapproved limits of removal because the pipe was damaged due to negligence on the part of the Contractor shall be replaced by the Contractor, in kind, at no cost to DEN. Removal of underdrain cleanouts shall include piping, backfill, filter fabric and any encasement material such as concrete and flowfill and capping the end of the existing underdrain to remain. Removed material shall be disposed of off-site.

**101-4.10 Remove Existing Grouted Riprap.** Measurement for payment of Remove Existing Grouted Rip Rap shall be made per square yard based on the area approved for removal by

DEN and actually removed during construction. The thickness of the existing material to be removed is approximate only and the Contractor will not be reimbursed for areas that may be thicker than shown on the plans. Remove Existing Grouted Rip Rap shall include all breaking, excavation, hauling, cleaning and/or disposal (including disposal fees) of rip rap material necessary to facilitate removal and/or reuse of the material on site.

**101-4.11 Removal of Electrical Items.** The unit of measurement for removal of lights, electrical ground wells, junction boxes, electrical manholes, signs, and other miscellaneous electrical items will be made at the contract unit price for each completed and accepted item, including foundations. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

### BASIS OF PAYMENT

**101-5.1 Payment.** Payment shall be made at contract unit price for the unit of measurement as specified above. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

P-101-5.1	Remove Concrete Pavement - 17" Non-Reinforced (Full Depth)	- per square yard
P-101-5.2	Remove Concrete Pavement - 17" Reinforced (Full Depth)	- per square yard
P-101-5.3	Remove Concrete Pavement - 17" Non-Reinforced (Slab Only)	- per square yard
P-101-5.4	Remove Bituminous Taxiway Shoulder Pavement - 10" (Full Depth)	- per square yard
P-101-5.5	Remove VSR Bituminous Pavement - 10" (Full Depth)	- per square yard
P-101-5.6	Remove VSR Bituminous Pavement - 8" (Full Depth)	- per square yard
P-101-5.7	Remove Roller Compacted Concrete Pavement - 8" (Full Depth)	- per square yard
P-101-5.8	Remove Concrete Pavement - 6" (Full Depth)	- per square yard
P-101-5.9	Cold Milling - 3" Depth	- per square yard
P-101-5.10	Remove 12-Inch Steel Pipe	- per linear feet
P-101-5.11	Remove 18-Inch RCP Drainage Pipe	- per linear feet
P-101-5.12	Remove 24-Inch PVC Drainage Pipe	- per linear feet
P-101-5.13	Remove 24-Inch RCP Drainage Pipe	- per linear feet
P-101-5.14	Remove 30-Inch RCP Drainage Pipe	- per linear feet
P-101-5.15	Remove 54-Inch RCP Drainage Pipe	- per linear feet
P-101-5.16	Remove 60-Inch RCP Drainage Pipe	- per linear feet

**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-101 PREPARATION/REMOVAL OF EXISTING PAVEMENTS**

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P-101-5.17	Remove Underdrain Pipe	- per linear feet
P-101-5.18	Remove Underdrain Cleanout	- per each
P-101-5.19	Remove SDG Manhole/Inlet	- per each
P-101-5.20	Remove DIW Manhole/Inlet	- per each
P-101-5.21	Remove DIW Force Main Manhole	- per each
P-101-5.22	Removal of Headwall and Wingwalls	- per each
P-101-5.23	Remove Flared End Section	- per each
P-101-5.24	Remove Existing Riprap	- per square yard
P-101-5.25	Remove 50,000 Gallon Steel Oil/Water Separator Tank	- per lump sum
P-101-5.26	Remove Electrical Ground Well	- per each
P-101-5.27	Remove Water Quality Structure	- per each
P-101-5.28	Remove DIW Force Main 8" PVC Pipe	- per linear feet
P-101-5.30	Remove Electrical Handhole	- per each
P-101-5.31	Remove Elevated Light and Base Can, Complete	- per each
P-101-5.32	Remove In-Pavement Light and Base Can, Complete	- per each
P-101-5.33	Remove SRE Receptacle Panelboard, Transformer, and Foundation, Complete	- per lump sum
P-101-5.34	Remove SRE Engine Block Heater Receptacle Rack	- per lump sum
P-101-5.35	Remove High Mast Light Pole and Foundation, Complete	- per each
P-101-5.36	Remove Guidance Sign and Foundation	- per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

**END OF ITEM P-101**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-101 PREPARATION/REMOVAL OF EXISTING PAVEMENTS**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item P-152 Excavation, Subgrade, and Embankment

### DESCRIPTION

**152-1.1** This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas; as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

**152-1.2 Classification.** All material excavated shall be classified as defined below:

- a. Unclassified excavation.** Unclassified excavation shall consist of the excavation and placement of all material, regardless of its nature, which is not otherwise classified and paid for under one of the items listed in Sections 152-1.2 and 152-1.3. Unclassified Excavation shall consist of material cut within the project construction limits and placed within the construction limits as embankment or structural fill. Unclassified Excavation includes, as incidental to the work, any required import material to fill voids beneath the proposed pavement section for purposes of backfilling utility and structure excavations.
- b. Borrow excavation.** Borrow excavation shall consist of approved imported Lower Select Embankment Material, and approved imported Upper Select Embankment material required for the construction of the P-220 Cement-Treated Soil Base Course. Borrow material shall be obtained from areas designated by the DEN Project Manager (DEN PM), within the limits of the Airport property, but outside the normal limits of necessary grading, or from areas outside the Airport. Borrow Embankment shall be verified to meet the requirements of P-152-1.4, in accordance with P-152-1.5, prior to placement on-site as embankment fill.
- c. Waste Excavation.** Waste Excavation shall consist of either (1) over-excavated existing native subgrade soils or (2) DEN Select Material (beneath the existing lime-treated subgrade), which are in excess of that needed for new pavement section construction.
  - Waste Excavation (1) is the volumetric difference of material which is cut between the native material surface, following stripping and topsoil removals, and the bottom of the imported Lower Select material.
  - Waste Excavation (2) is the volumetric difference of material which is cut between the bottom of the existing lime-treated subgrade and the bottom of the imported Upper-Select material. Waste Excavation (2) shall consist of materials beneath existing PCCP pavement sections, which meet the requirements of DEN Select Embankment and which are found to be uncontaminated and suitable, following required in-place testing by the Contractor of these materials.

Waste Excavation material shall be placed in the Unsuitable Soil Disposal Area noted on the Plans. Waste Excavation materials shall be placed, graded, and compacted on Airport Property, as designated by the DEN PM, in accordance with the requirements of P-152-2.12. Alternatively, the material may simply be stockpiled, at the discretion of the DEN PM.

- d. Common Embankment.** Common Embankment shall consist of material which is not contaminated, is not deemed “Unsuitable,” and is not classified as defined above, to exclude topsoil material and rock excavation.

**152-1.3 Unsuitable excavation.** Unsuitable material shall be disposed in designated waste areas, as shown on the plans. Materials containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material suitable for topsoil may be used on the embankment slope, when approved by the DEN PM.

Material found to contain contaminants or hazardous materials shall be handled in accordance with the provisions of Section 017419 – *Construction Waste Management and Disposal*. Excavation. Disposal of contaminated soils shall be measured and paid for as incidental to “Unclassified Excavation – Export to Waste Area.”

**152-1.4 Select Embankment.** Select Embankment shall consist of material, as described below.

- Lower-Select Embankment: the lower 4.5-feet of embankment fill.
- Upper-Select Embankment: the upper 1.5-feet of embankment fill.

The upper 12-inches of the Upper-Select Embankment will be cement-treated, in accordance with Item P-220 Cement-Treated Soil Base Course.

**a. Lower-Select Embankment.** Lower-Select Embankment material shall consist of existing in-place select fill under existing pavement sections (found to be “suitable”) or material sourced from approved borrow sources on the Airport. Moisture conditioning of in-place existing Lower-Select fill shall be performed to a depth of 8 to 12-inches below planned finished grades or to 3-feet below existing site grades (DEN frost depth), whichever is greater.

Over-excavation and replacement of existing soils to 3-feet below existing site grades (DEN frost depth) shall be completed to a maximum 12-inch lift thickness. Reconditioning of the native Lower Select material will be performed to a depth of either 8-inches or 12-inches, depending on the on-site condition of the soils. In-situ materials which are undisturbed through construction activities will be reconditioned in-place to a depth of 8-inches. Material which is found to be unsuitable (P-152-1.3) will be excavated and replaced with import material to a depth of 12-inches. Materials which are disturbed due to construction activities (utility repair trenches etc.) will be reconditioned to a depth of 12-inches. Reconditioning that is to take place in confined spaces which limit access by heavy equipment shall be reconditioned to a depth of 8-inches. All existing Lower Select soils shall be reconditioned to achieve optimum moisture/density, regardless of depth and location, to provide for minimized swell potential upon exposure to subsurface moisture.

Imported Lower-Select Embankment materials shall be free of unsuitable materials (including claystone), contain 100% passing the 3-inch sieve, less than 90% passing the No. 200 sieve, and less than 3% swell potential. The swell sample shall be remolded to 95% of the maximum dry density at optimum moisture and wetted while under 200 psf surcharge, as determined by ASTM D 698 for initial acceptance of the proposed imported Lower-Select Embankment Material. During placement of the imported Lower-Select Embankment Material, the swell sample shall be obtained from the compacted in-place imported Lower Select Embankment Material.

Lower-Select Embankment materials should be properly moisture-conditioned and compacted, in accordance with this specification.

**b. Upper-Select Embankment.** Upper-Select Embankment material shall be obtained from the borrow area(s) indicated in the Plans, and tested to be certified free of contaminants. Upper-Select Embankment material, of which the upper 12-inches will be cement-treated per Item P-

220, shall be an imported material free of unsuitable materials, with 100% passing the 1-inch sieve, no more than 45% retained on a No. 4 sieve, less than 70% passing the No. 200 sieve, a maximum water soluble sulfates content of 0.5%, and less than 3% swell potential. The swell sample shall be remolded to 95% of the maximum dry density at optimum moisture and wetted while under 200 psf surcharge, as determined by ASTM D 698 for initial acceptance of the proposed Upper-Select Embankment material.

During placement of the Upper-Select Embankment material, the swell sample shall be obtained from the compacted in-place Upper-Select Embankment material. Upper-Select Embankment materials shall be properly moisture-conditioned and compacted, in accordance with this specification.

**152-1.5 Material Classification.** Non-cohesive soils, for the purposes of determining compaction control, are those with a Plasticity Index (PI) of less than 3, when tested in accordance with ASTM D 4318. Any other material shall be considered cohesive.

### **CONSTRUCTION METHODS**

**152-2.1 General.** Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with contract and as approved by the DEN PM. This work shall be measured and paid for as incidental to the associated work items.

The suitability of material to be placed in embankments shall be subject to approval by the DEN PM. All unsuitable material shall be disposed of in waste areas as shown on the plans. All waste areas shall be graded to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas shall be specified on the plans or approved by the DEN PM.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued, and the DEN PM notified per Section 70, paragraph 70-20. At the direction of the DEN PM, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4-inches, (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6-inches (150 mm) of the subgrade.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the DEN PM, who shall arrange for their removal if necessary. The Contractor, at their own expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

**a. Blasting.** Blasting shall not be allowed.

**152-2.2 Excavation.** No excavation shall be started until the work has been staked out by the Contractor, and the DEN PM has obtained from the Contractor the survey notes of the elevations and measurements of the ground surface. The Contractor and DEN PM shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

Digital terrain model (DTM) files of the existing surfaces, finished surfaces, and other various surfaces were used to develop the design plans. Volumetric quantities were calculated by comparing DTM files of the applicable design surfaces and generating Triangle Volume Reports. Electronic copies of DTM files will be issued to the successful bidder.

Existing grades on the DTMs, where they do not match the locations of actual spot elevations shown on the topographic map, were developed by computer interpolation from those spot elevations. Prior to disturbing original grade, Contractor shall verify the accuracy of the existing ground surface by verifying spot elevations at the same locations where original field survey data was obtained as indicated on the topographic map. Contractor shall recognize that, due to the interpolation process, the actual ground surface at any particular location may differ somewhat from the interpolated surface shown on the design cross sections or obtained from the DTM's. Contractor's verification of original ground surface, however, shall be limited to verification of spot elevations as indicated herein, and no adjustments will be made to the original ground surface, unless the Contractor demonstrates that spot elevations shown are incorrect. For this purpose, spot elevations which are within 0.1 foot of the stated elevations for ground surfaces, or within 0.04 foot for hard surfaces (pavements, buildings, foundations, structures, etc.) shall be considered "no change". Only deviations in excess of these will be considered for adjustment of the original ground surface. If the Contractor's verification identifies discrepancies in the topographic map, Contractor shall notify the DEN PM in writing at least two weeks before disturbance of existing grade, to allow sufficient time to verify the submitted information and make adjustments to the design cross sections or DTM's. Disturbance of existing grade in any area shall constitute acceptance by the Contractor of the accuracy of the original elevations shown on the topographic map for that area.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the DEN PM. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes as shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the DEN PM. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes as shown on the plans. All Unsuitable Material shall be disposed of as outlined in P-152-1.3.

The grade shall be maintained so that the surface is well drained at all times.

When the volume of the excavation exceeds that required to construct the embankments to the grades as indicated on the plans, the excess shall be used to grade the areas of ultimate development or disposed as directed by the DEN PM. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from pre-approved borrow areas, as indicated on the Plans.

- a. Selective grading.** When selective grading is indicated on the plans, the more suitable material designated by the DEN PM shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved, and no separate measurement or payment shall be made for this work.
- b. Undercutting.** Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be

excavated to a minimum depth of 12-inches below the subgrade or to the depth specified by the DEN PM. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed of at locations shown on the plans and as indicated in P-152-1.3. This excavated material shall be paid for at the contract unit price per cubic yard for “Unclassified Excavation – Export to Waste Area”. The excavated area shall be backfilled in accordance with specification provisions with suitable material obtained from the grading operations or borrow areas. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with lower select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans. Undercutting will be paid as “Unclassified Excavation – Export to Waste Area.”

- c. Over-break.** Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the DEN PM. All over-break shall be graded or removed by the Contractor and disposed of as directed by the DEN PM. The DEN PM shall determine if the displacement of such material was unavoidable and their own decision shall be final. Payment will not be made for the removal and disposal of over-break that the DEN PM determines as avoidable. Unavoidable over-break will be classified as “Unclassified Excavation – Export to Waste Area.”
- d. Removal of utilities.** The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by the Contractor, as indicated on the plans. All existing foundations shall be excavated at least 2-feet below the top of subgrade, or as indicated on the plans, and the material disposed of as directed by the DEN PM. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

**152-2.3 Borrow excavation.** Borrow areas within the Airport property are indicated on the plans. Borrow excavation shall be made only at these designated locations and within the horizontal and vertical limits as staked, or as directed by the DEN PM. All unsuitable material shall be disposed of by the Contractor as shown on the plans and as outlined in P-152-1.3. All borrow pits shall be opened to expose the various strata of acceptable material to allow obtaining a uniform product. Borrow areas shall be drained and left in a neat, presentable condition with all slopes dressed uniformly. Borrow areas shall not create a wildlife attractant.

The Contractor shall identify borrow sources to distinguish materials to be used as select embankment. The Contractor shall prepare a Select Embankment Material Plan for select material excavation and select material placement, based on the plan information and the Contractor's further exploration of select embankment material availability.

The Select Embankment Material Plan shall contain the results of the following investigation:

- a.** Select Borrow investigation for designated areas.
- b.** Test hole or pit explorations in select borrow areas at approximately 300-foot on center.
- c.** Sample testing at each exploration for depth of topsoil, depth of select material, elevation of surface, and laboratory tests for Plasticity Index, sieve analysis, percent passing 200 sieve, classification, soluble sulfates, and swell consolidation. All materials shall be tested for the presence of contaminants and hazardous materials. All soils testing shall be paid for as incidental to the work.
- d.** Detailed log of each test hole or pit.
- e.** Estimate of select material available in each area.

When borrow sources are outside the boundaries of the airport property, it shall be the Contractor's responsibility to locate and obtain the borrow source, subject to the approval of the DEN PM. The Contractor shall notify the DEN PM at least 15 days prior to beginning the excavation, so necessary measurements and tests can be made. All borrow pits shall be opened up to expose the various strata of acceptable material to allow obtaining a uniform product. All unsuitable material shall be disposed of by the Contractor. Borrow pits shall be excavated to regular lines to permit accurate measurements, and they shall be drained and left in a neat, presentable condition, with all slopes dressed uniformly.

**152-2.4 Drainage excavation.** Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the DEN PM. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted. Work performed under this section shall be considered incidental to the project, and will not be measured or paid separately.

**152-2.5 Hazardous Materials.** Some material (equipment, debris, soil, wastes, etc.) may be affected by hazardous constituents, chemicals or compounds used during oil and gas production, residential development, public improvement construction, or agricultural use. Material contaminated or potentially contaminated with hazardous constituents, chemicals, or compounds shall be assessed by the Contractor regarding the hazardous characteristic(s) of each material. The assessment will be made in accordance with requirements specified by the Colorado Department of Public Health and Environment (CDPHE) and the Colorado Department of Natural Resources Oil and Gas Conservation Commission (OGCC). The Contractor shall notify the Engineer in writing immediately upon discovery or suspicion of the existence of such hazardous material. See Section 015719 for further requirements regarding identification and remediation of contaminated soils.

Material found to contain contaminants or hazardous materials shall be handled in accordance with the provisions of Section 017419.

**152-2.6 Preparation of cut areas or areas where existing pavement has been removed.** In those areas on which a subbase or base course is to be placed, the top 12-inches of subgrade shall be conditioned to optimum moisture and 95% of maximum density, as determined by ASTM D698.

**a. Subgrade Bridging.** Following removal of overburden (concrete pavement panels and underlying cement-treated base and lime-treated subgrade materials, or native soils in previously undeveloped areas to the depth of the bottom of the Lower Select Embankment), exploratory potholes shall be excavated to evaluate the composition and depth of any unstable or unsuitable material. The exploratory activities shall be performed using equipment that will minimize disturbance of underlying soft soils.

If there is no unstable or unsuitable material, the ground surface shall be scarified to the depth specified in P-152-1.4, moisture conditioned to within 2% of the optimum moisture content, and compacted to 95% of the ASTM D 698 maximum dry density. This work shall be measured and paid for as incidental to "Subgrade Remediation."

If unsuitable or unstable materials are identified at the depth of the bottom of proposed Lower Select Embankment fill, the excavated surface may be stabilized using 3-inch to 8-inch “bridging material” (recycled concrete crushed aggregate). Stabilization shall consist of first spreading an 18-inch thick lift of bridging material over the soft subgrade by pushing the material out over the soft subgrade in front of a piece of tracked equipment, or low ground pressure (LGP) tracked equipment as necessary, to avoid disturbance of the underlying soft soil. Additional lifts shall be spread and track-compacted as required to provide a sufficiently stable surface upon which to place the initial lift of embankment fill. Only the minimum thickness of bridging material necessary to provide a stable embankment foundation shall be used.

At the discretion of the DEN PM to ensure timely progress of the work, unsuitable or unstable native embankment materials may be bridged, in lieu of (1) removed to stable material and replaced with suitable lower embankment or (2) or reconditioned in-place, as described above. Unsuitable or unstable subgrade materials shall be reconditioned and mechanically stabilized (“bridged”) in lifts not-to-exceed 18-inches. Mechanical bridge stabilization may require application in several lifts to treat the affected area. Following mechanical stabilization, the area shall be proof-rolled in accordance with P-152-2.13 and approved by the DEN PM.

As an alternative to using the coarse-grained bridging material, a geogrid or geotextile stabilization fabric may be placed on the undisturbed soft subgrade and covered with a layer of finer ( $\frac{3}{4}$ -inch to 1 $\frac{1}{2}$ -inch) crushed concrete or aggregate using procedures similar to those described above for the “bridging material”. A bi-axial Type 2 geogrid or a stabilization geotextile meeting the requirements of strength Class 1 according to AASHTO M 288 shall be installed. Subgrade bridging methodology and materials shall be approved by the DEN PM, prior to implementation. Subgrade Bridging shall be measured and paid for as “Subgrade Bridging (18-inches),” as required via contract amendment.

**152-2.7 Preparation of embankment area.** All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 12-inches and shall then be compacted per P-152-2.12.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12-inches and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

**152-2.8 Control Strip.** The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the DEN PM, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12-inches upon the Contractor’s demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The DEN PM must witness this demonstration and approve the lift thickness, prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the DEN PM. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the DEN PM.

**152-2.9 Formation of embankments.** The material shall be constructed in lifts as established in the control strip, but not less than 6 inches nor more than 12-inches of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts, until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact, and re-test any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section, or as directed by the DEN PM. Materials such as brush, hedge, roots, stumps, grass, and other organic matter shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained, due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment, nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within +0% to +2% of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The Contractor shall take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D698. A new Proctor shall be developed for each soil type, as determined by the procedures outlined in P-152-1.5.

Density tests will be taken by the Contractor for every 3,000 square yards of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies as determined by the DEN PM.

If the material has greater than 30% retained on the 3/4-inch sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than 100% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D968. Under all areas to be paved, the embankments shall be compacted to a depth of 12-inches and to a density of not less than 95% percent of the maximum density as determined by ASTM D698.

On all areas outside of the pavement areas, no compaction will be required on the top 4-inches, which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with ASTM D1556 or ASTM 6938 using Procedure A, the direct transmission method. ASTM D6938 shall be used to determine

the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The Contractor's laboratory shall perform all density tests in the presence of the DEN PM and provide the test results upon completion to the DEN PM for acceptance. If the specified density is not attained, the area represented by the test or as designated by the DEN PM shall be re-worked and/or re-compacted and additional random tests shall be made. This procedure shall be followed until the specified density is reached.

Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained and is approved by the DEN PM.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment, as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4-inches in their greatest dimensions will not be allowed in the top 12-inches of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the DEN PM and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the DEN PM.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in lifts of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in lifts not exceeding 2-feet in thickness. Each lift shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The lift shall not be constructed above an elevation 4-feet below the finished subgrade.

Payment for compacted embankment will be made under "Unclassified Excavation – Embank On-Site."

**152-2.10 Proof rolling.** The purpose of proof-rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. After compaction is completed, the subgrade area shall be proof-rolled with a 20-ton Tandem-Axle Dual-Wheel Dump Truck loaded to the legal limit with tires inflated to 125 psi or a 15-ton Proof Roller with tires spaced not more than 32-inches on-center with tires inflated to 125 psi, in the presence of the DEN PM. Apply a minimum of 4 coverages, or as specified by the DEN PM, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1-inch, or show permanent deformation greater than 1-inch, shall be removed and replaced with suitable material or re-worked to conform to the moisture content and compaction requirements, in accordance with these specifications. Removal and replacement of soft areas is incidental to the work, and shall not be measured or paid for separately.

**152-2.11 Compaction requirements.** The subgrade under areas to be paved shall be compacted to a depth of 12-inches (8-inches, if Contractor cannot demonstrate competent result, per P-152-2.8 Control Strip) and to a density of not less than 100 percent of the maximum density for non-cohesive soils and 95 percent of the maximum dry density for cohesive soils as determined by ASTM D698. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12-inches and to a density of not less than 95 percent of the

maximum density for non-cohesive soils and 90 percent of the maximum density for cohesive soils as determined by ASTM D698.

The material to be compacted shall be within +0% to +2% of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the ¾ inch sieve, follow the methods in ASTM D698 or the procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles. Tests for moisture content and compaction will be taken at a minimum of 1,000 square yards of subgrade. All quality assurance testing shall be done by the Contractor's laboratory in the presence of the DEN PM, and density test results shall be furnished upon completion to the DEN PM for acceptance determination.

The in-place field density shall be determined in accordance with ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content, unless otherwise specified.

If the specified density is not attained, the entire lot shall be re-worked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the DEN PM and the finished subgrade shall be maintained.

**152-2.12 Excavation for Structures.** Excavate to indicated elevations and dimensions within a tolerance of plus-or-minus 1-inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services, other construction, and for inspections.

- a. Excavations for Footings and Foundations.** Do not disturb bottom of excavation. Excavate by hand to final grade, just prior to placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- b. Pile Foundations.** Stop excavations 6-to-12 inches above bottom of pile cap, before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
- c. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures.** Excavate to elevations and dimensions indicated, within a tolerance of plus or minus 1-inch. Do not disturb bottom of excavations intended as bearing surfaces.

**152-2.13 Excavation for Utility Trenches.** Contactor shall adhere to the following provisions when completing utility trench excavations.

- a.** Excavate trenches to indicated gradients, lines, depths, and elevations. Beyond building perimeters, excavate trenches to allow installation of top of pipe below frost line (36-inches below finish grade).
- b.** Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12-inches higher than top

of pipe or conduit, unless otherwise indicated. Clearance: 12-inches each side of pipe or conduit, or as indicated.

- c. Trench Bottoms.** Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
- 1) For pipes and conduit less than 6-inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - 2) For pipes and conduit 6-inches or larger in nominal diameter, shape bottom of trench to support bottom 90-degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
  - 3) For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
  - 4) Excavate trenches 6-inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
  - 5) Excavate trenches 4-inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Excavate trenches 6-inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

**152-2.14 Backfill.** Place and compact backfill in excavations promptly, but not before completing the following:

- a. Construction below finish grade including, where applicable, sub-drainage, damp-proofing, waterproofing, and perimeter insulation
- b. Surveying locations of underground utilities for Record Documents.
- c. Testing and inspecting of underground utilities.
- d. Removal of concrete formwork.
- e. Removal of trash and debris.
- f. Removal of temporary shoring, bracing, and sheeting.
- g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- h. Place backfill on subgrades free of mud, frost, snow, or ice.

**152-2.15 Utility Trench Backfill.** Place and compact backfill in utility trench excavations, in accordance with the following provisions:

- a. Place backfill on subgrades free of mud, frost, snow, or ice.
- b. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- c. **Trenches under Footings.** Backfill trenches excavated under footings and within 18-inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Item P-610.
- d. **Trenches under Roadways.** Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30-inches below surface of roadways. After installing and testing,

completely encase piping or conduit in a minimum of 4-inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Item P-610.

e. Backfill voids with satisfactory soil, while removing shoring and bracing.

**f. Initial Backfill:**

- 1) Soil Backfill: Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1-inch in any dimension, to a height of 12-inches over the pipe or conduit. Carefully compact initial backfill under pipe haunches, and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- 2) Controlled Low-Strength Material: Place initial backfill of P-153 controlled low-strength material to a height of 12-inches over the pipe or conduit. Coordinate backfilling with utilities testing.

**g. Final Backfill:**

- 1) Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- 2) Controlled Low-Strength Material: Place final backfill of P-153 controlled low-strength material to final subgrade elevation.

h. Coordinate backfilling with utilities testing.

i. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

j. Warning Tape: Install warning tape directly above utilities, 12-inches below finished grade, except 6-inches below subgrade under pavements and slabs.

**152-2.16 Finishing and Protection of Subgrade.** Finishing and protection of the subgrade is incidental to the work. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes, or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade, until the subgrade has been accepted by the DEN PM.

**152-2.17 Haul.** All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift, or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining, and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be

made for any work or materials associated with providing, maintaining, and removing haul roads or routes.

**152-2.18 Surface Tolerances.** In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 6-inches, reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the DEN PM. The Contractor shall perform all final smoothness and grade checks in the presence of the DEN PM. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

- a. **Smoothness.** The finished surface shall not vary more than +/- ½ inch, when tested with a 12-foot straight-edge applied parallel with and at right angles to the centerline. The straight-edge shall be moved continuously forward at half the length of the 12-foot straight-edge for the full length of each line on a 50-foot grid.
- b. **Grade.** The grade and crown shall be measured on a 50-foot grid and shall be within +/- 0.05 feet of the specified grade.

On safety areas, turfed areas, and other designated areas within the grading limits where no subbase or base is to be placed, grade shall not vary more than 0.10 feet from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding, or removing materials, and reshaping.

**152-2.19 Topsoil.** When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the DEN PM, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

**152-2.20 Restoring Borrow Areas.** The Contractor shall, upon completion of his borrow excavation activities, prepare the borrow site(s) for topsoiling and seeding by performing the following work:

- a. Remove and bury all rock over 6-inches in dimension in accordance with rock disposal methods, as noted under Section 2.5.
- b. Grade all sites to drain, as indicated in these specifications and the drawings.
- c. Remove all trash and other foreign objects, so that the areas can be re-used for farming purposes.
- d. Rip the borrow area site in a manner as approved by the DEN PM. After the area is ripped to the required 18-inch depth, the ripped area shall be treated on the surface to reduce excessive surface roughness or cloddiness and produce an area suitable for future seeding. Treatment may include discing, harrowing, culti-packing or other means as approved by the DEN PM. In areas where rock is the predominant surface remaining, the Contractor may

spread 18-inches of acceptable material over the rock areas, as approved by the DEN PM, at no additional cost to the Owner.

Disturbed areas shall be reclaimed in accordance with the provisions of Section 015719.

All work required to prepare the borrow area for top-soiling and seeding, as designated under this section, shall be considered as incidental work.

### **METHOD OF MEASUREMENT**

**152-3.1** Measurement for payment specified by the cubic yard shall be computed by the comparison of digital terrain model (DTM) surfaces for computation of neat line design quantities. The end area is that bound by the original ground line established by field cross-sections and the final theoretical pay line established by cross-sections shown on the plans, subject to verification by the DEN PM.

Measurement for payment specified by the square yard shall be measured in-place for the area completed and accepted by the DEN PM.

**152-3.2** The quantity of **Unclassified Excavation – Embank On-Site** to be paid for shall be the number of cubic yards measured in its original position, and utilized as on-site embankment material. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed. **152-3.3** The quantity of **Unclassified Excavation – Export to Waste Area** to be paid for shall be the number of cubic yards measured in its original position and hauled for offsite disposal. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.4** The quantity of **Lower Select Embankment** to be paid for shall be the number of cubic yards measured in its original position, sourced from offsite borrow sources on Airport property, and utilized as on-site embankment material. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.5** The quantity of **Upper Select Embankment** to be paid for shall be the number of cubic yards measured in its original position, sourced from offsite borrow sources on Airport property, and utilized as on-site embankment material. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.6** The quantity of **Subgrade Remediation** to be paid for shall be the number of square yards measured in its original position, accepted in place.

### **BASIS OF PAYMENT**

**152-4.1 Unclassified Excavation – Embank On-Site** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.2 Unclassified Excavation – Export to Waste Area** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.3 Lower Select Embankment** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.4 Upper Select Embankment** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.5 Subgrade Remediation** shall be made at the contract unit price per square yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-152-4.1	Subgrade Remediation – per square yard
Item P-152-4.2	Unclassified Excavation (Embank On-Site) - per cubic yard
Item P-152-4.3	Unclassified Excavation (Export to Waste Area) – per cubic yard
Item P-152-4.4	Lower Select Embankment – per cubic yard
Item P-152-4.5	Upper Select Embankment – per cubic yard

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

### American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

### ASTM International (ASTM)

ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))

ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2700 kN-m/m<sup>3</sup>))

ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

### Advisory Circulars (AC)

AC 150/5370-2 Operational Safety on Airports During Construction Software

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-152 EXCAVATION, SUBGRADE, AND EMBANKMENT**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

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**Software**

FAARFIELD            FAA Rigid and Flexible Iterative Elastic Layered Design

**U.S. Department of Transportation**

FAA RD-76-66            Design and Construction of Airport Pavements on Expansive Soils

**END OF ITEM P-152**

## Item P-153 Controlled Low-Strength Material (CLSM)

### DESCRIPTION

**153-1.1** This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the Resident Project Representative (RPR).

### MATERIALS

#### 153-2.1 Materials.

**a. Cement.** Cement shall conform to the requirements of ASTM C150 Type I, II, or V, or ASTM C595 Type IL, IS, IP, IT.

**b. Fly ash.** Fly ash shall conform to ASTM C618, Class C or F.

**c. Fine aggregate (sand).** Fine aggregate shall conform to the requirements of ASTM C33 except for aggregate gradation. Any aggregate gradation which produces the specified performance characteristics of the CLSM and meets the following requirements, will be accepted.

Sieve Size	Percent Passing by weight
3/4 inch (19.0 mm)	100
No. 200 (75 µm)	0 - 12

**d. Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**e.** The CLSM used in the construction of Item L-110, Duct Banks, shall have Red Color dye added.

### MIX DESIGN

**153-3.1 Proportions.** The Contractor shall submit, to the RPR, a mix design including the proportions and source of aggregate, fly ash, cement, water, and approved admixtures. No CLSM mixture shall be produced for payment until the RPR has given written approval of the proportions. The proportions shall be prepared by a laboratory and shall remain in effect for the duration of the project. The proportions shall establish a single percentage or weight for aggregate, fly ash, cement, water, and any admixtures proposed. Laboratory costs are incidental to this item.

**a. Compressive strength.** CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 1379 kPa) when tested in accordance with ASTM D4832, with no significant strength gain after 28 days.

**b. Consistency.** Design CLSM to achieve a consistency that will produce an approximate 8-inch (200 mm) diameter circular-type spread without segregation. CLSM consistency shall be determined per ASTM D6103.

## **CONSTRUCTION METHODS**

### **153-4.1 Placement.**

**a. Placement.** CLSM may be placed by any reasonable means from the mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed so structures or pipes are not displaced from their final position and intrusion of CLSM into unwanted areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed by the RPR. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one lift, the base lift shall be free of surface water and loose foreign material prior to placement of the next lift.

**b. Contractor Quality Control.** The Contractor shall collect all batch tickets to verify the CLSM delivered to the project conforms to the mix design. The Contractor shall verify daily that the CLSM is consistent with 153-3.1a and 153-3.1b. Adjustments shall be made as necessary to the proportions and materials as needed. The Contractor shall provide all batch tickets to the RPR.

**c. Limitations of placement.** CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air or ground temperature is at least 35°F (2°C) and rising. Mixing and placement shall stop when the air temperature is 40°F (4°C) and falling or when the anticipated air or ground temperature will be 35°F (2°C) or less in the 24-hour period following proposed placement. At the time of placement, CLSM shall have a temperature of at least 40°F (4°C).

### **153-4.2 Curing and protection**

**a. Curing.** The air in contact with the CLSM shall be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32°F (0°C), the material may be rejected by the RPR if damage to the material is observed.

**b. Protection.** The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the RPR that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 153-3.1a.

**153-4.3 Quality Assurance (QA) Acceptance.** CLSM QA acceptance shall be based upon batch tickets provided by the Contractor to the RPR to confirm that the delivered material conforms to the mix design.

## **METHOD OF MEASUREMENT**

### **153-5.1 Measurement.**

Controlled low-strength material (CLSM) shall be measured by the number of linear feet of existing waterline pipe encasement, as shown on the plans, completed, and accepted. All other CLSM shall not be measured, but shall be considered incidental to the installation of the new utility items.

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ITEM P-153 CONTROLLED LOW-STRENGTH  
MATERIAL (CLSM)

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### BASIS OF PAYMENT

#### 153-6.1 Payment.

Controlled low-strength material (CLSM) shall be paid for at the contract unit price per linear feet of existing waterline pipe encasement. Payment shall be full compensation for all materials, equipment, labor, and incidentals required to complete the work as specified.

Payment will be made under:

Item P-153-6.1      Waterline Pipe Encasement (CLSM) per linear foot.

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low-Strength Material (CLSM) Test Cylinders
ASTM D6103	Flow Consistency of Controlled Low Strength Material (CLSM)

**END OF ITEM P-153**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-153 CONTROLLED LOW-STRENGTH  
MATERIAL (CLSM)**

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## ITEM P-159 CONCRETE AND ASPHALT CRUSHING

### DESCRIPTION

**159-2.1** This item shall consist of providing all equipment, labor, and utilities necessary to crush and stockpile concrete and asphalt rubble removed from the project and hauled to the North Airfield Recycle Yard, as shown on the project drawings. The following recycled materials will be produced by this contract:

- a. CDOT, Class 6 Aggregate Base Course
- b. Additional size and quantity of material as directed by the DEN Project Manager or DEN Quality Assurance Recycling Yard Inspector.

### 159-2.2 RELATED SECTIONS AND DOCUMENTS.

Section 014510 – Contractor Quality Control

Section 014525 – Material Testing Agency

DEN Concrete and Asphalt Recycle Yards Standard Operating Procedures, (SOP); latest revision dated May 14, 2018

### 159-2.3 SUBMITTALS. (REFER TO SECTION 013300)

Gradation Test Reports

### PRODUCTS

**159-2.1 CLASS 6, CRUSHED AGGREGATE MATERIALS.** Aggregate base shall be material that has been crushed and screened to meet the gradation for CDOT, Class 6 material, as follows:

Sieve Size	% By Weight Passing Square Mesh Sieves
1 inch	100
$\frac{3}{4}$ inch	95-100
No. 4	30-65
No. 8	25-55
No. 200	3-12

Due to the quantity of fine material resulting from crushing concrete, the No. 200 material will be acceptable up to a maximum of 18%.

## EXECUTION

**159-3.1 STOCKPILING.** Removed materials shall be hauled to, crushed and stockpiled at the North Airfield Recycle Yard, as directed by the DEN Quality Assurance Recycling Yard Inspector. Stockpiles of differing materials (asphalt or concrete) shall be placed in locations on the site such that the separate materials will be readily accessible, as directed by the DEN Quality Assurance Recycling Yard Inspector. Separate differing materials with dividers or stockpile apart to prevent mixing. Direct surface water away from stockpile site so as to prevent erosion or deterioration of materials. Stockpile materials with stacking conveyors so as to minimize the footprint of each stockpile. The contractor will supply a conveyor at the discharge from the crusher that is equipped with a calibrated weight scale.

Ensure that all concrete reinforcing, dowel bars, joint sealant, fiber board, and electrical equipment of any nature are segregated from all stockpiles for disposal. All reinforcing metal, or any nature removed from the concrete rubble during crushing operations shall be separated from finished materials for later disposal or recycling by the contractor.

**159-3.2 SITE CLEAN UP.** At the completion of crushing and screening operations, grade site surface to prevent freestanding surface water. Remove all steel reinforcing from the site and dispose of it at either a steel recycling facility or at a state permitted landfill. Remove, and dispose offsite of any excess minus 200 sieve material which may have been generated by the crushing and screening work. Remove any materials used for environmental protection, except that silt fences down grade from stockpiles shall be left in place.

**159-3.3 TESTING.** Class 6 aggregate base course, either concrete or asphalt, will be tested by an independent testing agency following the first 1,000 tons of each material produced. A sieve analysis shall be performed by the Contractor's Independent Testing Agency, and results forwarded to the DEN Project Manager for approval. Following initial approval, additional sieve analyses shall be performed for each additional 5,000 tons of material produced. Reports of each test shall be forwarded to the DEN Project Manager.

## METHOD OF MEASUREMENT

**159-4.1 MEASUREMENT.** Measurement for work shall be the number of tons using the scale at the recycle yard.

## METHOD OF PAYMENT

**159-5.1 PAYMENT.** Payment will be made at the contract unit price per ton for concrete and cement treated base course crushing. This price shall be full compensation for all furnishing all materials, all preparation and placing the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item. The quantity produced of each type of material will be directed by the DEN PM or DEN Quality Assurance Recycling Yard Inspector.

Payment will be made under:

P-159-5.1 Crush PCCP Removals (Class 6) – per ton

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**TECHNICAL SPECIFICATIONS  
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ITEM P-159 CONCRETE AND ASPHALT CRUSHING**

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P-159-5.2 Crush CTB Removals (Class 6) – per ton

**TESTING REQUIREMENTS**

ASTM D75	Practice for Sampling Aggregates
ASTM C117	Materials Finer than 75um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C702	Practice for Reducing Samples of Aggregates to Testing Size

**END OF ITEM P-159**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-159 CONCRETE AND ASPHALT CRUSHING**

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## ITEM P-160 WATERING

### DESCRIPTION

**160-1.1** This work shall consist of obtaining, conveying, and applying water for compaction of embankments and subgrades; for concrete; haul road; for dust control; and for any other purposes in accordance with the requirements of the Contract Documents or as designated by the DEN Project Manager (DEN PM).

### MATERIALS

**160-2.1 WATER QUALITY.** Water required for construction use shall be clean and free from sewage, oil, acid, strong alkalis, organic material, and other substances injurious to the finished product. Water obtained from the City supplied source is acceptable for use as construction water. If the Contractor provides an alternative source for water supply, water of questionable quality shall be tested in accordance with ASTM C1602. All alternative supply sources shall be subject to approval by the DEN PM.

**160-2.2 CITY SUPPLIED WATER SOURCE.** The City shall make available a source of construction water from the water line close to the existing Contractor Staging Area location shown on the Drawings. There is not an unlimited supply of water available and the Contractor will be held responsible for misuse of water. The tap size shall be limited to 1-1/2 inches (38 mm).

It shall be the Contractor's responsibility to contact the Denver Water Department (DWD) and the DEN PM and arrange for connection to the above referenced waterline, to include installation of meter. The Contractor's connection plan, its distribution system, and its filling operations must be coordinated with, submitted to, and approved by the DWD prior to installation. All costs associated with waterline connections and distribution shall be included in the unit prices bid for the applicable items of construction.

**160-2.3 POTABLE WATER.** Potable water may be hauled in and stored by the Contractor.

### CONSTRUCTION METHODS

**160-3.1 TRANSPORT OF WATER.** The Contractor may transport water overland to an approved temporary storage facility, or construct temporary supply piping to his primary use point. The approximate location and alignment of the Contractor's temporary supply/distribution system must be approved by the DEN PM in writing prior to its installation and must be removed by the Contractor upon completion of work. Potential contamination of existing domestic water system shall be held as the responsibility of the contractor.

**160-3.2 EQUIPMENT.** The water equipment shall be of capacity and designed to assure uniform application of water in the amounts required.

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TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-160 WATERING

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**160-3.3 PERMITS.** The Contractor shall obtain the required DWD permit(s) relative to tapping the water line and/or the use of said water.

**METHOD OF MEASUREMENT**

**160-4.1** There shall be no direct measurement or payment for watering. The work under this item shall be considered subsidiary to other items of work.

**BASIS OF PAYMENT**

**160-5.1** Watering shall be considered incidental to the project. No payment shall be made for watering.

**TESTING REQUIREMENTS**

ASTM C1602            Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

**END OF ITEM P-160**

## Item P-220 Cement Treated Soil Base Course

### DESCRIPTION

**220-1.1** This item shall consist of constructing a base course by uniformly mixing soil, cement, and water. The mixed material shall be spread, shaped, and compacted in accordance with these specifications and in conformity to the dimensions and typical cross-section shown on the plans. Tests shall be required for each approved soil included within the treated layer.

Runway, taxiway, or apron pavements shall be built in a series of parallel lanes using a plan that reduces the number of longitudinal and transverse joints to a minimum.

### MATERIALS

**220-2.1 Cement.** Cement shall conform to the requirements of ASTM C150 Type V. Type I/II LA cement may be substituted for Type V cement, subject to DEN PM approval, should the Type I/II LA cement meet Type V requirements for sulfate resistance, deleterious activity, and total alkali content.

**220-2.2 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**220-2.3 Soil.** The soil for this work shall consist of the uppermost 12 inches of select embankment as placed and paid for by Specifications Item P-152, Upper Select Embankment.

**220-2.4 Asphalt material.** The types, grades, controlling specifications, and application temperatures for the asphalt materials used for curing the soil-cement shall be selected from the table below. The DEN PM will approve the specific material used.

#### Bituminous Materials

Type and Grade	Specification	Application Temperature	
		Degrees F	Degrees C
<b>Cutback Asphalt</b>			
RC-70	ASTM D2028	120-160	50-70
RC-250	ASTM D2028	160-200	70-95
<b>Emulsified Asphalt</b>			
RS-1, SS-1	ASTM D977	75-130	25-55
CRS-1	ASTM D2397	75-130	25-55

## MIX DESIGN

**220-3.1 Proportions.** Before the start of base course construction, tests shall be made on the soil or soil-aggregate material to be stabilized to determine the quantity of cement required for the mix design.

Test specimens containing various amounts of cement shall be compacted per ASTM D558, and the optimum moisture determined for each test specimen. Samples at the optimum moisture shall be subjected to the wet-dry and the freeze-thaw test in accordance with ASTM D559 and ASTM D560, respectively.

The specimens shall be tested for compressive strength in accordance with ASTM D1633. Tests are required for each approved soil which will be included in the treated layer

## CONSTRUCTION METHODS

**220-4.1 Control Strip.** The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the DEN Project Manager (DEN PM), that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The DEN PM must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted or removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the DEN PM. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved by the DEN PM.

**220-4.2 Weather limitations.** The material shall not be mixed or placed while the atmospheric temperature is below 40°F (4°C) or when conditions indicate that the temperature may fall below 40°F (4°C) within 24 hours, or when the weather is foggy or rainy, or to soils that are frozen or contain frost, or when the underlying material is frozen.

**220-4.3 Maintenance.** The material shall be maintained in a condition that will meet all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at their expense.

**220-4.4 Equipment.** The course may be constructed with any equipment that will meet the requirements for soil pulverization, cement application, mixing, water application, incorporation of materials, compaction, finishing, and curing specified here.

**220-4.5 Preparation.** The area to be stabilized shall be graded and shaped to conform to the lines, grades and cross-section shown on the plans. Any soft or yielding areas in the subgrade shall be removed and replaced with acceptable soil and compacted to the specified density.

**220-4.6 Pulverization.** After completion of moist-mixing, the soil for the base course shall be pulverized so that 100% by dry weight passes a 1-inch (25.0 mm) sieve and a minimum of 80% passes a No. 4 (4.75 mm) sieve.

**220-4.7 Cement application, mixing, and finishing.** Mixing of the soil, cement, and water shall be accomplished by one of the following methods to be approved by the DEN PM.

**a. Mix in Place Method.** Shape pulverized material to the cross-section indicated. Cement shall be applied so that when uniformly mixed with the soil, the specified cement content is obtained, and a sufficient quantity of cement-treated soil is produced to construct a compacted cement-treated course conforming to the lines, grades, and cross-section indicated. Immediately after the cement has been distributed, it shall be mixed with the soil. The cement shall not be mixed below the required depth. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Determine moisture content of the mixture immediately after completion of mixing of the soil and cement. Provide water supply and pressure distributing equipment that will permit the application within three (3) hours of all mixing water on the section being processed. Incorporate water in the mix so that concentration of water near the surface does not occur. After all mixing water has been applied, continue mixing until the water is uniformly distributed throughout the full depth of the mixture. Do not apply cement if the soil moisture content exceeds the optimum moisture content specified for the cement-treated mixture. After mixing is complete, the proportions of the mixture shall be in accordance with the approved mix design.

**b. Central Plant Mix Method.** Cement application, mixing, and spreading. Mixing of the soil, cement, and water shall be accomplished by the central-plant-mixed method. The soil, cement, and water shall be mixed in either a batch or continuous-flow type pugmill. The plant shall be equipped with feeding and metering devices that will add the soil, cement, and water into the mixer in the specified quantities. Soil and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform mixture of soil, cement, and water is obtained.

The mixture shall be hauled to the project in trucks equipped with protective covers. The mixture shall be placed on the moistened subgrade in a uniform layer by an approved spreader. Not more than 30 minutes shall elapse between the placement of soil-cement in adjacent lanes.

The layer of soil-cement shall be uniform in thickness and surface contour and of sufficient quantity that the completed base conforms to the required line, grade and cross-section. Dumping of the mixture in piles or windrows on the subgrade shall not be permitted.

Not more than 60 minutes shall elapse between the start of moist mixing and the start of compaction of soil-cement

**220-4.8 Compaction.** Compaction of the course shall begin within 30 minutes after mixing the cement into the subgrade. All compaction operations shall be completed within 2 hours from the start of mixing.

The field density of the compacted mixture shall be at least 98% of the maximum density as determined by ASTM D558. The in-place moisture content shall be determined in accordance with ASTM D2216. The moisture content of the mixture at the start of compaction shall be within  $\pm 2$  percentage points of the optimum moisture content. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**220-4.9 Finishing and curing.** After the final lift or course of treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

Finished portions of treated subgrade shall be protected to prevent equipment from marring, permanently deforming, or damaging completed work.

Not later than 24 hours after completion of final finishing, the surface shall be cured by application of an emulsified asphalt uniformly applied to the surface of the completed base course at the rate of approximately 0.2 gallons per square yard (0.91 l/m<sup>2</sup>). The curing material shall be maintained and applied as needed by the Contractor during the 7-day protection period.

Sufficient protection from freezing shall be provided for at least 7 days after its construction or as approved by the DEN PM.

**220-4.10 Construction limitations.** At the end of each day's construction and/or when operations after application of the cement are interrupted for more than 30 minutes, a straight transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true vertical face.

Completed portions may be opened to light traffic, if approved by the DEN PM, and provided the curing is not impaired.

**220-4.11 Surface tolerance.** In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the DEN PM. The Contractor shall perform all final smoothness and grade checks in the presence of the DEN PM. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

**a. Smoothness.** The finished surface shall not vary more than +/- 3/8 inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/-0.05 feet (15 mm) of the specified grade.

**220-4.12 Acceptance sampling and testing.** Cement Treated Solid Base course shall be accepted for density and thickness on an area basis. Two test will be made for density and thickness for each 1,200 square yards (1000 square meters), but not less than four (4) tests per day of production. Sampling locations will be determined on a random basis per ASTM D3665.

**a. Density.** The DEN PM shall perform all density tests.

Each area shall be accepted for density when the field density is at least 98% of the maximum density of laboratory specimens compacted and tested per ASTM D558. The in-place field density shall be determined per ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The in-place moisture content shall be determined in accordance with ASTM D2216. Perform in-place density test immediately after completion of compaction to determine degree of compaction. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified. If the specified density is not attained, the area represented by the failed test must be reworked and/or recompacted at the Contractor's expense and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**b. Thickness.** Depth tests shall be made by test holes or cores at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the

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Contractor in the presence of the DEN PM for each subplot. Where the thickness is deficient by more than 1/2-inch (12 mm), the material shall be removed to full depth and replaced, at Contractor's expense.

### **METHOD OF MEASUREMENT**

**220-5.1** The quantity of cement treated soil base course shall be the number of square yards (square meter) of completed and accepted base course.

**220-5.2** Cement shall be measured by the ton (kg).

### **BASIS OF PAYMENT**

**220-6.1** Payment shall be made at the contract unit price per square yard (m<sup>2</sup>) for cement treated soil base course. This price shall be full compensation for furnishing all materials, except cement, and for all preparation, delivering, placing, and mixing of these materials; and for all labor, equipment, tools and incidentals necessary to complete the item.

**220-6.2** Payment shall be made at the contract unit price per ton (kg) for cement. This price shall be full compensation for furnishing this material and for all delivery, placing, and incorporation of this material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-220-6.1	Cement Treated Soil Base Course (12-Inch) - per square yard
Item P-220-6.2	Cement Treated Soil Base Course (8-Inch) - per square yard
Item P-220-6.3	Cement - per ton

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C1632	Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory <sup>1</sup>
ASTM C1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D558	Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-220 CEMENT TREATED SOIL BASED COURSE****DENVER INTERNATIONAL AIRPORT**  
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ASTM D559	Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D560	Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil In-Place by the Sand Cone Method
ASTM D2027	Standard Specification for Cutback Asphalt (Medium-Curing Type)
ASTM D2028	Standard Specification for Cutback Asphalt (Rapid-Curing Type)
ASTM D2397	Standard Specification for Cationic Emulsified Asphalt
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**END OF ITEM P-220**

## Item P-304 Cement-Treated Aggregate Base Course (CTB)

### DESCRIPTION

**304-1.1** This item shall consist of a cement-treated base (CTB) course composed of mineral aggregate and cement, uniformly blended and mixed with water. The mixed material shall be spread and shaped with a mechanical spreader, and compacted with rollers in accordance with these specifications and in conformance to the lines, grades, dimensions, and cross-sections shown on the plans.

### MATERIALS

**304-2.1 Aggregate.** The aggregate shall be select granular materials, comprised of crushed or uncrushed gravel and/or stone, or recycled cement concrete. The material shall be free of roots, sod, and weeds. The crushed or uncrushed aggregate shall consist of hard, durable particles meeting the requirements in the table below.

#### Cement Treated Aggregate Base Material Requirements

Material Test	Requirement	Standard
<b>Coarse Aggregate Portion (retained on the No. 4 (4.75 mm) sieve)</b>		
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Flat Particles, Elongated Particles, or Flat and Elongated Particles <sup>1</sup>	10% maximum, by weight, for fraction retained on the ½ inch (12.5mm) sieve and 10% maximum, by weight, for the fraction passing the 1/2-inch (12.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
<b>Fine Aggregate Portion (Passing the No. 40 (425µm) sieve)</b>		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index	Not more than 6	ASTM D4318

<sup>1</sup> A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

**304-2.2 Gradation Requirements.** The aggregate shall conform to the gradation(s) shown in the table below per ASTM C136, A dense, well-graded aggregate blend that meets the requirements of the table shall be selected by the Contractor and used in the final mix design. The final aggregate blend shall be well graded from coarse to fine within the limits designated in

the table and shall not vary from the low limit on one sieve to the high limit on adjacent sieves, or vice versa.

### Aggregate Gradation for CTB Material

Sieve Size	Design Range Percentage by Weight Passing	Contractor's Final Gradation	Job Control Grading Band Tolerances for Contractor's Final Gradation <sup>2</sup> Percent
2 inch (50 mm)	100		±0
1 inch (25.0 mm)	90-100		±5
No. 4 (4.75 mm)	45-95		±8
No. 10 (2.00 mm)	37-80		±8
No. 40 (425 µm)	15-50		±5
No. 200 (75 µm)	0–15		±3

For Contractor quality control, sample the aggregate stockpile in accordance with ASTM D75 and perform gradation tests in accordance with ASTM C136 a minimum of once per week during production of CTB.

#### 304-2.3 Sampling and testing.

**a. Aggregate base materials.** The Contractor shall take samples of the aggregate base stockpile in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraphs 304-2.1 and 304-2.2. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

**304-2.4 Cement.** Cement shall conform to the requirements of ASTM C150, Type I or II, or ASTM C595 Type IP or IL.

**304-2.5 Cementitious additives.** Pozzolanic and slag cement may be added to the CTB mix. If used, each material must meet the following requirements:

**a. Pozzolan.** Pozzolanic materials must meet the requirements of ASTM C618, Class F, or N with the exception of loss of ignition, where the maximum shall be less than 6%.

**b. Slag cement (ground granulated blast furnace (GGBF) slag).** Slag shall conform to ASTM C989, Grade 100, or 120.

**304-2.6 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**304-2.7 Curing materials.** Curing material shall be a white-pigmented, liquid membrane-forming compound conforming to ASTM C309, Type 2, Class A or Class B (wax-based).

### COMPOSITION OF MIXTURE

**304-3.1 General.** The CTB material shall be composed of a mixture of aggregate, cementitious material, and water. Fly ash or slag cement may be used as a partial replacement for cement.

**304-3.2 Mix design.** The mix design shall use a cement content that, when tested in the laboratory per ASTM D1633, produces a 7-day compressive strength between 300 pounds per square inch (2068 kPa) minimum and 600 pounds per square inch (3447 kPa) maximum. Avoid higher strengths due to potential to cause shrinkage and reflective cracks.

Wet-dry and/or freeze-thaw tests shall be performed in accordance with ASTM D559 and ASTM D560 respectively. The weight loss for each type of test shall not exceed 14% after 12 cycles.

The mix design shall include a complete list of materials, including type, brand, source, and amount of cement, fine aggregate, coarse aggregate, water, and cementitious additives.

Should a change be made in aggregate sources or type of cement, or if cementitious additives are added or deleted from the mix, production of the CTB mix shall be stopped and a new mix design shall be submitted.

**304-3.3 Submittals.** At least 30 days prior to the placement of the CTB, the Contractor shall submit certified test reports to the DEN Project Manager (DEN PM) for those materials proposed for use during construction, as well as the mix design information for the CTB material. Tests older than six (6) months shall not be used. The certification shall show the ASTM or AASHTO specifications or tests for the material, the name of the company performing the tests, the date of the tests, the test results, and a statement that the material did or did not comply with the applicable specifications. The submittal package shall include the following:

- a. Source(s) of materials, including aggregate, cement, cementitious additives, curing, and bond-breaking materials.
- b. Physical properties of the aggregates, cement, cementitious additives, curing, and bond-breaking materials.
- c. Mix design:
  - Mix identification number
  - Aggregate gradation
  - Cement content
  - Water content
  - Cementitious materials content
  - Compaction and strength results
  - Laboratory compaction characteristics (maximum dry density and optimum moisture content)
  - Compressive strength at seven (7) days
  - Wet-dry and/or freeze-thaw weight loss

No CTB material shall be placed until the submittal is accepted in writing by the DEN PM.

During production, the Contractor shall submit batch tickets for each delivered load.

## **EQUIPMENT**

**304-4.1 Mixing.** The mixer shall be a batch or continuous-flow type stationary mixer that produces a well-blended, uniform mixture of aggregate, cement, water, and pozzolan. The mixer shall be equipped with calibrated metering and feeding devices that introduce the aggregate, cement, water, and cementitious additives (if used) into the mixer in the specified quantities.

The DEN PM shall have free access to the plant at all times for inspection of the plant's equipment and operation and for sampling the CTB mixture.

**304-4.2 Hauling.** The CTB material shall be transported from the plant to the job site in trucks or other hauling equipment having beds that are smooth, clean, and tight. Truck bed covers shall be provided and used to protect the CTB from weather. CTB material that becomes wet during transport shall be rejected.

**304-4.3 Placing.** CTB material shall be placed with a mechanical spreader capable of receiving, spreading, and shaping the mixture without segregation into a uniform layer or lift. The equipment shall be equipped with a strike-off plate and end gates capable of being adjusted to the layer thickness and width.

**304-4.4 Compaction.** The number, type, and weight of rollers and/or compactors shall be sufficient to compact the mixture to the required density.

## **CONSTRUCTION METHODS**

**304-5.1 Control Strip.** The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the DEN PM, that the materials, equipment, and construction processes meet the requirements of the specification. Control strips that do not meet specification requirements shall be removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the DEN PM. Upon acceptance of the control strip by the DEN PM, the Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the DEN PM.

**304-5.2 Weather limitations.** The CTB shall not be placed on frozen surfaces or when weather conditions will detrimentally affect quality of the finished course. Apply cement when the ambient temperature is a minimum of 40°F (4°C) and rising and aggregate are not frozen or contain frost. If ambient temperature falls below 40°F (4°C), protect completed CTB areas against freezing.

The Contractor should stop operations prior to and during rain allowing time to cover and protect any freshly placed material. Areas damaged by rain shall be replaced at the Contractor's expense.

**304-5.3 Maintenance.** Completed portions of the cement-stabilized area may be opened to local traffic provided the curing process is not impaired and to other traffic after the curing period has elapsed, provided that the cement-stabilized course has hardened sufficiently to prevent surface marring or distortion by equipment or traffic. Protect finished portions of cement stabilized base from traffic of equipment used in constructing adjoining sections in a manner to prevent marring or damaging completed work. The CTB shall be protected from freezing until covered.

**304-5.4 Preparation of underlying course.** The underlying course shall be checked by the DEN PM before placing and spreading operations are started. Prior to placing the material, the final grade should be firm, moist and free of frost. Use of chemicals to eliminate frost will not be permitted. The underlying course shall be wetted in advance of placing the CTB layer.

**304-5.5 Grade control.** Grade control between the edges of the CTB shall be accomplished at intervals of 50 feet (15 m) on the longitudinal grade and at 25 feet (7.5 m) on the transverse grade.

**304-5.6 Placing.** The CTB mixture shall be deposited on the moistened subgrade or subbase and spread into a uniform layer of specified width and thickness that, when compacted and trimmed, conforms to the required line, grade, and cross-section. The longitudinal joints shall be located so there is no offset a 2 foot (600 mm) minimum offset from planned joints in any overlying layer. Placement of the material shall begin along the centerline of the pavement on a crowned section or on the highest elevation contour of a pavement with variable cross slope.

The Contractor shall install the CTB layer in single compacted layer no greater than 6 inches (150 mm) thick.

**304-5.7 Compaction.** All compaction operations shall be completed within 2 hours from the start of mixing. The field density of the compacted mixture shall be at least 98% of the maximum density in accordance with paragraph 304-6.1a. At the start of compaction, the moisture content shall be within  $\pm 2$  percentage points of the specified optimum moisture. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**304-5.8 Finishing.** After compaction, shape the surface of the CTB layer to the specified lines, grades, and cross-section. During the finishing process, the surface shall be kept moist by means of fog-type sprayers. Compaction and finishing shall produce a smooth, dense surface, free of ruts, cracks, ridges, and loose material.

**304-5.9 Construction limitations.** All placement, compaction, and finishing operations shall be completed within two (2) hours from the start of mixing. Material not completed within the 2-hour time limit shall be removed and replaced at the Contractor's expense.

At the end of each day's construction and/or when operations are interrupted for more than 30 minutes, a straight transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true vertical face.

Completed portions may be opened to light traffic, if approved by the DEN PM, and provided the curing is not impaired.

**304-5.10 Curing.** The compacted and finished CTB shall be cured with the approved curing agents as soon as possible, but in no case later than two (2) hours after completion of the finishing operations. Curing material(s) shall meet the requirements in paragraph 304-2.7. The layer shall be kept moist using a moisture-retaining cover or a light application of water until the curing material is applied.

The surface of the CTB layer shall be uniformly sprayed with a liquid membrane-forming curing compound at the rate of one gallon (3.8 liters) to not more than 100 square feet (9.3 m<sup>2</sup>) to obtain a uniform cover over the surface. Hand spraying of odd widths or shapes and CTB surfaces exposed by the removal of forms is permitted.

The curing seal shall be maintained and protected until the pavement is placed. If the surface of the finished CTB and/or the curing seal becomes damaged, additional curing material shall be applied at the time it is damaged or when the damage is first observed.

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**304-5.11 Surface tolerance.** The Contractor shall perform smoothness and grade checks in the presence of the DEN PM. Any area not meeting smoothness and grade shall be corrected by the Contractor at the Contractor's expense.

**a. Smoothness.** The finished surface shall not vary more than  $\pm 3/8$ -inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline, and, moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade shall be measured on a 50-foot (15-m) grid and shall be within  $\pm 0.05$  feet (15 mm) of the specified grade.

**304-5.12 Bond-breaker.** No bond breaker is required.

### **MATERIAL ACCEPTANCE**

**304-6.1 Acceptance sampling and testing.** Cement Treated Aggregate base course shall be accepted for density and thickness on an area basis. Two tests shall be made for density and thickness for each 1200 square yards (1000 square meters), but not less than four (4) tests per day of production. Sampling locations will be determined on a random basis per ASTM D3665.

**a. Density testing.** CTB samples representing the material placed shall be taken to establish density and moisture requirements in accordance with ASTM D558. Additional CTB samples will be taken as necessary to verify density and moisture requirements. The DEN PM shall perform all density tests.

Each area shall be accepted for density when the field density is at least 98% of the maximum density of laboratory specimens. The in-place field density shall be determined in accordance with ASTM D1556 or ASTM D6938, Procedure A, direct transmission method. The in-place moisture content shall be determined in accordance with ASTM D2216. Perform in-place density test immediately after completion of compaction to determine degree of compaction. If the material fails to meet the density requirements, compaction shall continue or the material shall be removed and replaced at the Contractor's expense. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**b. Thickness.** The thickness of the CTB shall be determined by survey on a 25-foot (7.5 m) by 25-foot (7.5 m) survey grid.

When the thickness measurement is deficient by more than 1/2 inch (12 mm), the area represented by the tests shall be removed and replaced at the Contractor's expense.

### **METHOD OF MEASUREMENT**

**304-7.1 Cement-treated base course.** The quantity of cement-treated base course will be determined by measurement of the number of square yards ( $m^2$ ) of CTB actually constructed and accepted by the DEN PM as complying with the plans and specifications.

### **BASIS OF PAYMENT**

**304-8.1 Cement-treated base course.** Payment shall be made at the contract unit price per square yard ( $m^2$ ) for cement-treated base course. This price shall be full compensation for furnishing all materials, including cement; for all preparation, manipulation, placing, and curing

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of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-304-8.1      Cement Treated Base Course (8-Inch) – per square yard

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### ASTM International (ASTM)

ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C150	Standard Specification for Portland Cement
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregate
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D558	Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D559	Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D560	Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

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**TECHNICAL SPECIFICATIONS  
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ASTM D1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D2397	Standard Specification for Cationic Emulsified Asphalt
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**END OF ITEM P-304**

## ITEM P-304C CDOT AGGREGATE BASE COURSE (FOR ACCESS ROADS ONLY)

### DESCRIPTION

**304C-1.1** This work consists of furnishing and placing one or more courses of aggregate on a prepared base course.

### MATERIALS

**304C-2.1 AGGREGATE** Aggregates for bases shall be crushed stone, crushed slag, crushed gravel, natural gravel, or crushed reclaimed concrete or asphalt material which conforms to the quality requirements of AASHTO M 147 except that the requirements for the ratio of minus No. 200 sieve fraction to the minus No. 40 sieve fraction, stated in 2.2.2 of AASHTO M 147, shall not apply. Aggregates for bases shall meet the grading requirements of Table 1. The liquid limit shall not be greater than 30 and the plasticity index shall not exceed 6 when the aggregate is tested in accordance with AASHTO T 89 and T 90 respectively.

**TABLE 1**

**CLASSIFICATION FOR AGGREGATE BASE COURSE (CLASS 6)**

Sieve Size	Design Range - Percentage by Weig
1 in	100
3/4 in	95-100
No. 4	30-65
No. 8	25-55
No. 200	3-12

Acceptance will be based on random samples taken from each lift.

**304C-2.2 SEPARATION GEOTEXTILE.** Separation geotextile Class 2; 0.02 sec<sup>-1</sup> permittivity per ASTM D4491; Apparent opening size per ASTM D4751 with 0.60 mm maximum average value.

### CONSTRUCTION METHODS

**304C-3.1 PLACING.** If the required compaction depth of the aggregate base course exceeds 6 inches, it shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

**304C-3.2 MIXING.** The Contractor shall mix the aggregate by methods that insure a thorough and homogeneous mixture.

**304C-3.3 SHAPING AND COMPACTION.** Compaction of each layer shall continue until a density of not less than 95 percent of the maximum density determined in accordance with AASHTO T 180 as modified by CP 23 has been achieved. The moisture content shall be at +/-2 percent of optimum moisture content. The surface of each layer shall be maintained during the compaction operations so that a uniform texture is produced and the aggregates are firmly keyed. Moisture conditioning shall be performed uniformly during compaction.

Compaction of each reclaimed asphalt pavement aggregate layer shall continue until a wet density of not less than 95 percent of the maximum wet density when determined in accordance with a one point AASHTO T 180, Method D test has been achieved.

The surface of the base course will be tested with a 12-foot straightedge. The surface shall be tested prior to placement of the pavement. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall not exceed 3/8-inch. All irregularities exceeding the specified tolerance shall be corrected to the satisfaction of the DEN Project Manager at no additional cost to the Owner.

#### METHOD OF MEASUREMENT

**304C-4.1** CDOT Aggregate Base Course will be measured by the square yard compacted in place.

**304C-4.2** Separation geotextile shall be measured by the number of square yards of materials placed and accepted by the DEN PM as complying with the plans and specifications excluding seam overlaps and edge anchoring.

#### BASIS OF PAYMENT

**304C-5.1** Payment shall be made at the contract unit price per square yard of CDOT aggregate base course. This price shall be full compensation for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item. Water will not be measured and paid for separately but shall be included in the work.

**304C-5.2** Payment shall be made at the contract unit price per square yard for separation geotextile-class 2. The price shall be full compensation for furnishing all labor, equipment, material, anchors, and necessary incidentals.

Payment will be made under:

Item P-304C-5.1	CDOT Aggregate Base Course, Class 6 (6-Inch)– per square yard
Item P-304C-5.2	Separation Geotextile – per square yard

#### TESTING REQUIREMENTS

AASHTO T 89	Standard Method Test for Determining the Liquid Limit of Soils
AASHTO T 90	Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils

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**TECHNICAL SPECIFICATIONS**  
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AASHTO T 180      Standard Method of Test for Moisture-Density Relations of Soils

**MATERIAL REQUIREMENTS**

AASHTO M 147      Standard Specification for Materials for Aggregate and Soil-Aggregate  
Subbase, Base and Surface Courses

**END OF ITEM P-304C**

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## Item P-401 Asphalt Mix Pavement

### DESCRIPTION

**401-1.1** This item shall consist of pavement courses composed of mineral aggregate and asphalt binder mixed in a central mixing plant and placed on a prepared base or stabilized course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

### MATERIALS

**401-2.1 Aggregate.** Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand, and mineral filler, as required. The aggregates should have no known history of detrimental pavement staining due to ferrous sulfides, such as pyrite. Coarse aggregate is the material retained on the No. 4 (4.75 mm) sieve. Fine aggregate is the material passing the No. 4 (4.75 mm) sieve.

**a. Coarse aggregate.** Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Coarse aggregate material requirements are given in the table below.

### Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Percentage of Fractured Particles	For pavements designed for aircraft gross weights of 60,000 pounds (27200 kg) or more: Minimum 75% by weight of particles with at least two fractured faces and 85% with at least one fractured face <sup>1</sup>	ASTM D5821
	For pavements designed for aircraft gross weights less than 60,000 pounds (27200 kg): Minimum 50% by weight of particles with at least two fractured faces and 65% with at least one fractured face <sup>1</sup>	
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 <sup>2</sup>	ASTM D4791
Bulk density of slag <sup>3</sup>	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29.

<sup>1</sup> The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

<sup>2</sup> A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

<sup>3</sup> Only required if slag is specified.

**b. Fine aggregate.** Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel and shall be free from coatings of clay, silt, or other objectionable matter. Natural (non-manufactured) sand may be used to obtain the gradation of the fine aggregate blend or to improve the workability of the mix. Fine aggregate material requirements are listed in the table below.

### Fine Aggregate Material Requirements

Material Test	Requirement	Standard
Liquid limit	25 maximum	ASTM D4318
Plasticity Index	4 maximum	ASTM D4318
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Sand equivalent	45 minimum	ASTM D2419

**c. Sampling.** ASTM D75 shall be used in sampling coarse and fine aggregate.

**401-2.2 Mineral filler.** Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler shall meet the requirements of ASTM D242.

### Mineral Filler Requirements

Material Test	Requirement	Standard
Plasticity Index	4 maximum	ASTM D4318

**401-2.3 Asphalt binder.** Asphalt binder shall conform to ASTM D6373 Performance Grade (PG) 64-22.

### Asphalt Binder PG Plus Test Requirements

Material Test	Requirement	Standard
Elastic Recovery	75% minimum	ASTM D6084 <sup>1</sup>

<sup>1</sup> Follow procedure B on RTFO aged binder.

**401-2.4 Anti-stripping agent.** Any anti-stripping agent or additive (anti-strip) shall be heat stable and shall not change the asphalt binder grade beyond specifications. Anti-strip shall be an approved material of the Department of Transportation of the State in which the project is located.

## COMPOSITION

**401-3.1 Composition of mixture(s).** The asphalt mix shall be composed of a mixture of aggregates, filler and anti-strip agent if required, and asphalt binder. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

**401-3.2 Job mix formula (JMF) laboratory.** The laboratory used to develop the JMF shall possess a current certificate of accreditation, listing D3666 from a national accrediting authority and all test methods required for developing the JMF; and be listed on the accrediting authority's website. A copy of the laboratory's current accreditation and accredited test methods

shall be submitted to the Resident Project Representative (DEN PM) prior to start of construction.

**401-3.3 Job mix formula (JMF).** No asphalt mixture shall be placed until an acceptable mix design has been submitted to the DEN PM for review and accepted in writing. The DEN PM's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

When the project requires asphalt mixtures of differing aggregate gradations and/or binders, a separate JMF shall be submitted for each mix. Add anti-stripping agent to meet tensile strength requirements.

The JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 401-3.2. The asphalt mixture shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared and compacted using the gyratory compactor in accordance with ASTM D6925.

Should a change in sources of materials be made, a new JMF must be submitted to the DEN PM for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the DEN PM and a new or modified JMF is required for whatever reason, the subsequent cost of the new or modified JMF, including a new control strip when required by the DEN PM, will be borne by the Contractor.

The DEN PM may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates proposed for project use.

The JMF shall be dated, and stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF in accordance with paragraph 401-2.3. Certificate of asphalt performance grade is with modifier already added, if used and must indicate compliance with ASTM D6373. For plant modified asphalt binder, certified test report indicating grade certification of modified asphalt binder.
- Manufacturer's Certificate of Analysis (COA) for the anti-stripping agent if used in the JMF in accordance with paragraph 401-2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 401-2.1.
- Percent passing each sieve size for individual gradation of each aggregate cold feed and/or hot bin; percent by weight of each cold feed and/or hot bin used; and the total combined gradation in the JMF.
- Specific Gravity and absorption of each coarse and fine aggregate.
- Percent natural sand.
- Percent fractured faces.
- Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).

- Percent of asphalt.
- Number of blows or gyrations
- Laboratory mixing and compaction temperatures.
- Supplier-recommended field mixing and compaction temperatures.
- Plot of the combined gradation on a 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.
- Tensile Strength Ratio (TSR).
- Type and amount of Anti-strip agent when used.
- Asphalt Pavement Analyzer (APA) results.
- Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.

**Table 1. Asphalt Design Criteria**

<b>Test Property</b>	<b>Value</b>	<b>Test Method</b>
Number of blows or gyrations	75	
Air voids (%)	3.5	ASTM D3203
Percent voids in mineral aggregate (VMA), minimum	See Table 2	ASTM D6995
Tensile Strength Ratio (TSR) <sup>1</sup>	not less than 80 at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA) <sup>2,3</sup>	Less than 10 mm @ 4000 passes	AASHTO T340 at 250 psi hose pressure at 64°C test temperature

<sup>1</sup> Test specimens for TSR shall be compacted at  $7 \pm 1.0$  % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

<sup>2</sup> AASHTO T340 at 100 psi hose pressure at 64°C test temperature may be used in the interim. If this method is used the required Value shall be less than 5 mm @ 8000 passes

<sup>3</sup> Where APA not available, use Hamburg Wheel test (AASHTO T-324) 10mm @ 20,000 passes at 50°C.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM C136 and ASTM C117.

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the sources of supply; be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

**Table 2. Aggregate - Asphalt Pavements**

Sieve Size	Percentage by Weight Passing Sieve
1 inch (25.0 mm)	--
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	90-100
3/8 inch (9.5 mm)	72-88
No. 4 (4.75 mm)	53-73
No. 8 (2.36 mm)	38-60
No. 16 (1.18 mm)	26-48
No. 30 (600 µm)	18-38
No. 50 (300 µm)	11-27
No. 100 (150 µm)	6-18
No. 200 (75 µm)	3-6
<b>Minimum Voids in Mineral Aggregate (VMA)<sup>1</sup></b>	15.0
<b>Asphalt Percent:</b>	
Stone or gravel	5.0 – 7.5*
Slag	6.5 – 9.5
<b>Recommended Minimum Construction Lift Thickness</b>	2 inch

<sup>1</sup>To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition.

**Table 2. Aggregate - Asphalt Pavements**

Sieve Size	Percentage by Weight Passing Sieves		
	Gradation 1	Gradation 2	Gradation 3 <sup>1</sup>
1 inch (25.0 mm)	100	--	--
3/4 inch (19.0 mm)	90-100	100	--
1/2 inch (12.5 mm)	68-88	90-100	100
3/8 inch (9.5 mm)	60-82	72-88	90-100
No. 4 (4.75 mm)	45-67	53-73	58-78
No. 8 (2.36 mm)	32-54	38-60	40-60
No. 16 (1.18 mm)	22-44	26-48	28-48
No. 30 (600 µm)	15-35	18-38	18-38
No. 50 (300 µm)	9-25	11-27	11-27
No. 100 (150 µm)	6-18	6-18	6-18
No. 200 (75 µm)	3-6	3-6	3-6
Minimum Voids in Mineral Aggregate (VMA)	14.0	15.0	16.0
<b>Asphalt percent by total weight of mixture:</b>			
Stone or gravel	4.5-7.0	5.0-7.5	5.5-8.0
Slag	5.0-7.5	6.5-9.5	7.0-10.5
Recommended Minimum Construction Lift Thickness	3 inch	2 inch	1 1/2 inch

<sup>1</sup> Gradation 3 is intended for leveling courses. FAA approval is required for use in other locations.

**401-3.4 Reclaimed asphalt pavement (RAP).** RAP shall not be used.

**401-3.5 Control Strip.** Full production shall not begin until an acceptable control strip has been constructed and accepted in writing by the DEN PM. The Contractor shall prepare and place a quantity of asphalt according to the JMF. The underlying grade or pavement structure upon which the control strip is to be constructed shall be the same as the remainder of the course represented by the control strip.

The Contractor will not be allowed to place the control strip until the Contractor quality control program (CQCP), showing conformance with the requirements of paragraph 401-5.1, has been accepted, in writing, by the DEN PM.

The control strip will consist of at least 250 tons (227 metric tons) or 1/2 subplot, whichever is greater. The control strip shall be placed in two lanes of the same width and depth to be used in production with a longitudinal cold joint. The cold joint must be cut back in accordance with paragraph 401-4.14 using the same procedure that will be used during production. The cold joint for the control strip will be an exposed construction joint at least four (4) hours old or when

the mat has cooled to less than 160°F (71°C). The equipment used in construction of the control strip shall be the same type, configuration and weight to be used on the project.

The control strip will be considered acceptable by the DEN PM if the gradation, asphalt content, and VMA are within the action limits specified in paragraph 401-5.5a; and Mat density greater than or equal to 94.5%, air voids 3.5% +/- 1%, and joint density greater than or equal to 92.5%.

If the control strip is unacceptable, necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made and another control strip shall be placed. Unacceptable control strips shall be removed at the Contractor's expense.

The control strip will be considered one lot for payment based upon the average of a minimum of 3 samples (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 401-8.1 using a lot pay factor equal to 100.

## CONSTRUCTION METHODS

**401-4.1 Weather limitations.** The asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the DEN PM, if requested; however, all other requirements including compaction shall be met.

**Table 4. Surface Temperature Limitations of Underlying Course**

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40 <sup>1</sup>	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

**401-4.2 Asphalt plant.** Plants used for the preparation of asphalt shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 including the following items.

**a. Inspection of plant.** The DEN PM, or DEN PM's authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

**b. Storage bins and surge bins.** The asphalt mixture stored in storage and/or surge bins shall meet the same requirements as asphalt mixture loaded directly into trucks. Asphalt mixture shall not be stored in storage and/or surge bins for a period greater than twelve (12) hours. If the DEN PM determines there is an excessive heat loss, segregation, or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

**401-4.3 Aggregate stockpile management.** Aggregate stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the asphalt batch plant.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

**401-4.4 Hauling equipment.** Trucks used for hauling asphalt shall have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the DEN PM. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

**401-4.4.1 Material transfer vehicle (MTV).** Material transfer vehicles used to transfer the material from the hauling equipment to the paver, shall use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation. Material transfer vehicles are not required but may be used.

**401-4.5 Asphalt pavers.** Asphalt pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The asphalt paver shall be equipped with a control system capable of automatically maintaining the specified screed grade and elevation.

If the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued.

The paver shall be capable of paving to a minimum width specified in paragraph 401-4.12.

**401-4.6 Rollers.** The number, type, and weight of rollers shall be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing of the aggregate, depressions or other damage to the pavement surface. Rollers shall be in good condition, clean, and capable of operating at slow speeds to avoid displacement of the asphalt. All rollers shall be specifically designed and suitable for compacting asphalt concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used.

**401-4.7 Density device.** The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall supply a qualified technician during all paving operations to calibrate the gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the DEN PM upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

**401-4.8 Preparation of asphalt binder.** The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. The temperature of unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles,

but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

**401-4.9 Preparation of mineral aggregate.** The aggregate for the asphalt shall be heated and dried. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

**401-4.10 Preparation of Asphalt mixture.** The aggregates and the asphalt binder shall be weighed or metered and mixed in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all asphalt upon discharge shall not exceed 0.5%.

**401-4.11 Application of Prime and Tack Coat.** Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A tack coat shall be applied in accordance with Item P-603 to all vertical and horizontal asphalt and concrete surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

**401-4.12 Laydown plan, transporting, placing, and finishing.** Prior to the placement of the asphalt, the Contractor shall prepare a laydown plan with the sequence of paving lanes and width to minimize the number of cold joints; the location of any temporary ramps; laydown temperature; and estimated time of completion for each portion of the work (milling, paving, rolling, cooling, etc.). The laydown plan and any modifications shall be approved by the DEN PM.

Deliveries shall be scheduled so that placing and compacting of asphalt is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to approximately ambient temperature. The Contractor, at their expense, shall be responsible for repair of any damage to the pavement caused by hauling operations.

Contractor shall survey each lift of asphalt surface course and certify to DEN PM that every lot of each lift meets the grade tolerances of paragraph 401-6.2d before the next lift can be placed.

Edges of existing asphalt pavement abutting the new work shall be saw cut and the cut off material and laitance removed. Apply a tack coat in accordance with P-603 before new asphalt material is placed against it.

The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the asphalt mix shall begin along the centerline of a crowned section or on the high side of areas with a one way slope unless shown otherwise on the laydown plan as accepted by the DEN PM. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 15 feet (m) except where edge lanes require less width to complete the area. Additional screed sections attached to widen the paver to meet the minimum lane

width requirements must include additional auger sections to move the asphalt mixture uniformly along the screed extension.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least one foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m). On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the asphalt may be spread and luted by hand tools.

The DEN PM may at any time, reject any batch of asphalt, on the truck or placed in the mat, which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or overheated asphalt mixture. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the DEN PM, and if it can be demonstrated in the laboratory, in the presence of the DEN PM, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

Areas of segregation in the surface course, as determined by the DEN PM, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraph 401-3.3, Table 2 for the approved mix design. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

**401-4.13 Compaction of asphalt mixture.** After placing, the asphalt mixture shall be thoroughly and uniformly compacted by self-propelled rollers. The surface shall be compacted as soon as possible when the asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any surface defects and/or displacement occurring as a result of the roller, or from any other cause, shall be corrected at the Contractor's expense.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the asphalt to the roller, the wheels shall be equipped with a scraper and kept moistened with water as necessary.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power tampers.

Any asphalt that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

**401-4.14 Joints.** The formation of all joints shall be made to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid asphalt except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the

adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh asphalt against the joint.

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. Asphalt tack coat in accordance with P-603 shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint. The cost of this work shall be considered incidental to the cost of the asphalt.

**401-4.15 Saw-cut grooving.** Saw-cut grooving is not required.

**401-4.16 Diamond grinding.** Diamond grinding shall be completed prior to pavement grooving. Diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive.

Diamond grinding shall be performed with a machine designed specifically for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with a sufficient number of blades to create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Equipment or grinding procedures that cause ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted. Contractor shall demonstrate to the DEN PM that the grinding equipment will produce satisfactory results prior to making corrections to surfaces. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

**401-4.17 Nighttime paving requirements.** The Contractor shall provide adequate lighting during any nighttime construction. A lighting plan shall be submitted by the Contractor and approved by the DEN PM prior to the start of any nighttime work. All work shall be in accordance with the approved CSPP and lighting plan.

### **CONTRACTOR QUALITY CONTROL (CQC)**

**401-5.1 General.** The Contractor shall develop a Contractor Quality Control Program (CQCP) in accordance with Item C-100. No partial payment will be made for materials without an approved CQCP.

**401-5.2 Contractor quality control (QC) facilities.** The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The DEN PM shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The DEN PM will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

**401-5.3 Contractor QC testing.** The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications [ ] and as set forth in the approved CQCP. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A QC Testing Plan shall be developed as part of the CQCP.

**a. Asphalt content.** A minimum of two tests shall be performed per day in accordance with ASTM D6307 or ASTM D2172 for determination of asphalt content. When using ASTM D6307, the correction factor shall be determined as part of the first test performed at the beginning of plant production; and as part of every tenth test performed thereafter. The asphalt content for the day will be determined by averaging the test results.

**b. Gradation.** Aggregate gradations shall be determined a minimum of twice per day from mechanical analysis of extracted aggregate in accordance with ASTM D5444, ASTM C136, and ASTM C117.

**c. Moisture content of aggregate.** The moisture content of aggregate used for production shall be determined a minimum of once per day in accordance with ASTM C566.

**d. Moisture content of asphalt.** The moisture content shall be determined once per day in accordance with AASHTO T329 or ASTM D1461. CDOT Procedure CP43 is also an acceptable method of determining the moisture content of the asphalt.

**e. Temperatures.** Temperatures shall be checked, at least four times per day, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the asphalt at the plant, and the asphalt at the job site.

**f. In-place density monitoring.** The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

**g. Smoothness for Contractor Quality Control.**

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the DEN PM. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, of FHWA ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

**(1) Transverse measurements.** Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the DEN PM. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

**(2) Longitudinal measurements.** Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously material the first measurement shall start with one half of the length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 401-4.16 or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 401-6.1d(3). Areas that have been ground shall be sealed with a surface treatment in accordance with Item P-608. To avoid the surface treatment creating any conflict with runway or taxiway markings, it may be necessary to seal a larger area.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

**h. Grade.** Grade shall be evaluated daily to allow adjustments to paving operations when grade measurements do not meet specifications. As a minimum, grade shall be evaluated prior to and after the placement of the first lift and after placement of the surface lift.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically. The documentation will be provided by the Contractor to the DEN PM by the end of the following working day.

Areas with humps or depressions that exceed grade or smoothness criteria and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 401-4.16.

The Contractor shall repair low areas or areas that cannot be corrected by grinding by removal of deficient areas to the depth of the final course plus 1/2 inch and replacing with new material. Skin patching is not allowed.

**401-5.4 Sampling.** When directed by the DEN PM, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

**401-5.5 Control charts.** The Contractor shall maintain linear control charts for both individual measurements and range (i.e. difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day will be calculated and monitored by the QC laboratory.

Control charts shall be posted in a location satisfactory to the DEN PM and kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the DEN PM may suspend production or acceptance of the material.

**a. Individual measurements.** Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts shall use the job mix formula target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

**Control Chart Limits for Individual Measurements**

Sieve	Action Limit	Suspension Limit
3/4 inch (19.0 mm)	±6%	±9%
1/2 inch (12.5 mm)	±6%	±9%
3/8 inch (9.5 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (300 µm)	±3%	±4.5%
No. 200 (75 µm)	±2%	±3%
<b>Asphalt Content</b>	±0.45%	±0.70%
<b>Minimum VMA</b>	-0.5%	-1.0%

**b. Range.** Control charts shall be established to control gradation process variability. The range shall be plotted as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of  $n = 2$ . Should the Contractor elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for  $n = 3$  and by 1.27 for  $n = 4$ .

### Control Chart Limits Based on Range

Sieve	Suspension Limit
1/2 inch (12.5 mm)	11%
3/8 inch (9.5 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (300 µm)	6%
No. 200 (75 µm)	3.5%
<b>Asphalt Content</b>	0.8%

**c. Corrective Action.** The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

- (1) One point falls outside the Suspension Limit line for individual measurements or range; or
- (2) Two points in a row fall outside the Action Limit line for individual measurements.

**401-5.6 QC reports.** The Contractor shall maintain records and shall submit reports of QC activities daily, in accordance with Item C-100.

## MATERIAL ACCEPTANCE

**401-6.1 Acceptance sampling and testing.** Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the DEN PM at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

**a. Quality assurance (QA) testing laboratory.** The QA testing laboratory performing these acceptance tests will be accredited in accordance with ASTM D3666. The QA laboratory accreditation will be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing will be listed on the lab accreditation.

**b. Lot size.** A standard lot will be equal to one day's production divided into approximately equal sublots of between 400 to 600 tons. When only one or two sublots are produced in a day's production, the sublots will be combined with the production lot from the previous or next day.

Where more than one plant is simultaneously producing asphalt for the job, the lot sizes will apply separately for each plant.

**c. Asphalt air voids.** Plant-produced asphalt will be tested for air voids on a subplot basis.

**(1) Sampling.** Material from each subplot shall be sampled in accordance with ASTM D3665. Samples shall be taken from material deposited into trucks at the plant or at the job site in accordance with ASTM D979. The sample of asphalt may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to maintain the material at or above the compaction temperature as specified in the JMF.

**(2) Testing.** Air voids will be determined for each subplot in accordance with ASTM D3203 for a set of three compacted specimens prepared in accordance with ASTM D6925.

**d. In-place asphalt mat and joint density.** Each subplot will be tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

**(1) Sampling.** The Contractor will cut minimum 5 inch (125 mm) diameter samples in accordance with ASTM D5361. The Contractor shall furnish all tools, labor, and materials for cleaning, and filling the cored pavement. Laitance produced by the coring operation shall be removed immediately after coring, and core holes shall be filled within one day after sampling in a manner acceptable to the DEN PM.

**(2) Bond.** Each lift of asphalt shall be bonded to the underlying layer. If cores reveal that the surface is not bonded, additional cores shall be taken as directed by the DEN PM to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as directed by the DEN PM.

**(3) Thickness.** Thickness of each lift of surface course will be evaluated by the DEN PM for compliance to the requirements shown on the plans after any necessary corrections for grade. Measurements of thickness will be made using the cores extracted for each subplot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch (6 mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, will not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or subplot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the DEN PM to circumscribe the deficient area.

**(4) Mat density.** One core shall be taken from each subplot. Core locations will be determined by the DEN PM in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each subplot sample by the TMD for that subplot.

**(5) Joint density.** One core centered over the longitudinal joint shall be taken for each subplot that has a longitudinal joint. Core locations will be determined by the DEN PM in accordance with ASTM D3665. The bulk specific gravity of each core sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the lot. The TMD used to determine the joint density at joints formed between lots will be the lower of the average TMD values from the adjacent lots.

#### **401-6.2 Acceptance criteria.**

**a. General.** Acceptance will be based on the implementation of the Contractor Quality Control Program (CQCP) and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density, grade.

**b. Air Voids and Mat density.** Acceptance of each lot of plant produced material for mat density and air voids will be based on the percentage of material within specification limits (PWL). If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment will be determined in accordance with paragraph 401-8.1.

**c. Joint density.** Acceptance of each lot of plant produced asphalt for joint density will be based on the PWL. If the PWL of the lot is equal to or exceeds 90%, the lot will be considered acceptable. If the PWL is less than 90%, the Contractor shall evaluate the reason and act

accordingly. If the PWL is less than 80%, the Contractor shall cease operations and until the reason for poor compaction has been determined. If the PWL is less than 71%, the pay factor for the lot used to complete the joint will be reduced by five (5) percentage points. This lot pay factor reduction will be incorporated and evaluated in accordance with paragraph 401-8.1.

**d. Grade.** The final finished surface of the pavement shall be surveyed to verify that the grade elevations shown on the paving plans do not deviate more than 1/2 inch (12 mm) vertically.

The survey and documentation shall be stamped and signed by a licensed surveyor. Payment for sublots that do not meet grade for over 25% of the subplot shall not be more than 95%.

**e. Profilograph roughness for QA Acceptance.** Not used.

**401-6.3 Percentage of material within specification limits (PWL).** The PWL will be determined in accordance with procedures specified in Item C-110. The specification tolerance limits (L) for lower and (U) for upper are contained in Table 5.

**Table 5. Acceptance Limits for Air Voids and Density**

Test Property	Pavements Specification Tolerance Limits	
	L	U
<b>Air Voids Total Mix (%)</b>	2.0	5.0
<b>Surface Course Mat Density (%)</b>	92.8	-
<b>Base Course Mat Density (%)</b>	92.0	-
<b>Joint density (%)</b>	90.5	--

**a. Outliers.** All individual tests for mat density and air voids will be checked for outliers (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded, and the PWL will be determined using the remaining test values. The criteria in Table 5 is based on production processes which have a variability with the following standard deviations: Surface Course Mat Density (%), 1.30; Base Course Mat Density (%), 1.55; Joint Density (%), 1.55.

The Contractor should note that (1) 90 PWL is achieved when consistently producing a surface course with an average mat density of at least 94.5% with 1.30% or less variability, (2) 90 PWL is achieved when consistently producing a base course with an average mat density of at least 94.0% with 1.55% or less variability, and (3) 90 PWL is achieved when consistently producing joints with an average joint density of at least 92.5% with 1.55% or less variability.

**401-6.4 Resampling pavement for mat density.**

**a. General.** Resampling of a lot of pavement will only be allowed for mat density, and then, only if the Contractor requests same, in writing, within 48 hours after receiving the written test results from the DEN PM. A retest will consist of all the sampling and testing procedures contained in paragraphs 401-6.1d and 401-6.2b. Only one resampling per lot will be permitted.

(1) A redefined PWL will be calculated for the resampled lot. The number of tests used to calculate the redefined PWL will include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

**b. Payment for resampled lots.** The redefined PWL for a resampled lot will be used to calculate the payment for that lot in accordance with Table 6.

**c. Outliers.** Check for outliers in accordance with ASTM E178, at a significance level of 5%.

### **METHOD OF MEASUREMENT**

**401-7.1 Measurement.** Asphalt shall be measured by the number of tons of asphalt mixture, including binder, used in the accepted work. Batch weights or truck scale weights will be used to determine the basis for the tonnage.

### **BASIS OF PAYMENT**

**401-8.1 Payment.** Payment for a lot of asphalt meeting all acceptance criteria as specified in paragraph 401-6.2 shall be made based on results of tests for mat density and air voids. Payment for acceptable lots shall be adjusted according to paragraph 401-8.1c for mat density and air voids; and paragraph 401-6.2c for joint density, subject to the limitation that:

**a.** The total project payment for plant mix asphalt pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons (kg) of asphalt used in the accepted work.

**b.** The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

**c. Basis of adjusted payment.** The pay factor for each individual lot shall be calculated in accordance with Table 6. A pay factor shall be calculated for both mat density and air voids. The lot pay factor shall be the higher of the two values when calculations for both mat density and air voids are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either mat density or air voids is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both mat density and air voids are less than 100%. If PWL for joint density is less than 71% then the lot pay factor shall be reduced by 5% but be no higher than 95%.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 401-8.1a. Payment in excess of 100% for accepted lots of asphalt shall be used to offset payment for accepted lots of asphalt pavement that achieve a lot pay factor less than 100%.

Payment for sublots which do not meet grade in accordance with paragraph 401-6.2d after correction for over 25% of the subplot shall be reduced by 5%.

**Table 6. Price adjustment schedule<sup>1</sup>**

Percentage of material within specification limits (PWL)	Lot pay factor (percent of contract unit price)
96 – 100	106
90 – 95	PWL + 10
75 – 89	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject <sup>2</sup>

<sup>1</sup> Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment above 100% shall be subject to the total project payment limitation specified in paragraph 401-8.1a.

<sup>2</sup> The lot shall be removed and replaced. However, the DEN PM may decide to allow the rejected lot to remain. In that case, if the DEN PM and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50% of the contract unit price and the total project payment shall be reduced by the amount withheld for the rejected lot.

**d. Profilograph Roughness.** Not used.

**401-8.1 Payment.**

Payment will be made under:

Item P-401-8.1	Bituminous Base Course – per ton
Item P-401-8.2	Bituminous Surface Course – per ton

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates

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ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979	Standard Practice for Sampling Asphalt Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Asphalt Paving Mixtures
ASTM D1188	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Asphalt Paving Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Asphalt Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures

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ASTM D5361	Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084	Standard Test Method for Elastic Recovery of Bituminous Materials by Duclilometer
ASTM D6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder
ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyrotory Compactor.
ASTM D6995	Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (Gmm)
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E950	Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
AASHTO T329	Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
AASHTO T324	Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures
AASHTO T 340	Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA)

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Asphalt Institute (AI)

Asphalt Institute Handbook MS-26, Asphalt Binder  
Asphalt Institute MS-2Mix Design Manual, 7th Edition  
AI State Binder Specification Database

Federal Highway Administration (FHWA)

Long Term Pavement Performance Binder Program

Advisory Circulars (AC)

AC 150/5320-6      Airport Pavement Design and Evaluation

FAA Orders

5300.1      Modifications to Agency Airport Design, Construction, and  
Equipment Standards

Software

FAARFIELD

**END OF ITEM P-401**

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## Item P-405 Asphalt Treated Permeable Base (Central Plant Hot Mix)

### DESCRIPTION

**405-1.1 General.** This item shall consist of an open-graded asphalt treated permeable base (atpb) composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the plans.

Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished and approved before the placement of the next course.

### MATERIALS

**405-2.1 Aggregate.** Aggregates shall consist of crushed stone or crushed gravel with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 4 sieve shall be known as the coarse aggregate. The portion passing the No. 4 sieve and retained on the No. 200 sieve shall be known as the fine aggregate, and the portion passing the No. 200 sieve is mineral filler.

**a. Coarse Aggregate.** Coarse aggregate shall consist of sound, tough durable particles, free from adherent films of matter that would prevent thorough coating and bonding with the bituminous material and be free from organic matter and other deleterious substances. The percentage of wear shall not be greater than 40 percent when tested in accordance with ASTM C 131 (aggregate below 1 ½ inches). The sodium sulfate soundness loss shall not exceed 20 percent or the magnesium sulfate soundness loss shall not exceed 13 percent, after five cycles, when tested in accordance with ASTM C 88.

The source of coarse aggregate shall be from quarried rock or river gravel. No slag shall be permitted. All aggregates shall have demonstrated a satisfactory service record of at least 10 years duration under similar conditions of service and exposure. Aggregate shall contain at least 90 percent by weight of crushed pieces having two or more fractured faces and 85 percent by weight having at least one fractured face. The area of each face shall be equal to at least 75 percent of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. Fractured faces shall be obtained by artificial crushing. The aggregate shall not contain more than a total of 8 percent, by weight, of flat particles, elongated particles, and flat and elongated particles, when tested in accordance with ASTM D 4791 with a total value 31 of 5:1.

**b. Fine Aggregates.** Fine aggregate shall consist of clean, sound, durable, angular shaped particles produced by crushing stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls.

The fine aggregate, including any blended material for the fine aggregate, shall have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification. The fine aggregate shall not contain more than 15 percent natural sand by weight of total aggregates.

The aggregate shall have sand equivalent values of 30 or greater when tested in accordance with ASTM D 2419.

c. **Sampling.** ASTM D 75 shall be used in sampling coarse and fine aggregate and ASTM C 183 shall be used in sampling mineral filler.

**405-2.2 Bituminous Material.** The bituminous material shall be viscosity grade PG 64-22 conforming to ASTM D3381, Table 2. The material shall not be mixed above the allowable maximum mixing temperature of 325 °F nor below a minimum temperature of 275 °F.

The Contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the DEN Project Manager before permission is granted for use of the material. The vendor's certified test report for the bituminous material can be used as a basis for final acceptance. However, the DEN PM reserves the right to have the material tested and reject it if the asphalt cement does not meet the specifications.

**405-2.3 Anti-Stripping Agent.** Hydrated lime shall be added at a minimum dosage rate of 0.5 percent by weight of the aggregate. The amount of hydrated lime used shall be sufficient to produce a coated area above 95 percent and added to the mix design by an approved method.

## COMPOSITION

**405-3.1 Composition OF MIXTURE.** The bituminous plant mix shall be composed of a mixture of aggregate, bituminous material and lime. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

**405-3.2 Job Mix Formula.** No bituminous mixture shall be produced for payment until the DEN PM or Designer has given written approval of the job mix formula. The job mix shall be prepared by a certified laboratory at the Contractor's expense and shall remain in effect for the duration of the project. The job mix formula shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, the amount of anti-strip agent to be added (minimum of one half of one percent by weight), and a single temperature for the mixture as it is discharged into the hauling units. Proper asphalt content shall be determined by mixing trial batches in the laboratory.

The job mix formula shall be submitted to the DEN PM at least 30 days prior to the start of paving and shall include:

- a. Percent passing each sieve size and gradation requirements.
- b. Percent of asphalt cement.
- c. Asphalt viscosity.
- d. Mixing temperature range.
- e. Temperature of mix when discharged from the mixer.
- f. Temperature viscosity relationship of the asphalt cement.
- g. Percent of wear (LA abrasion).
- h. Plasticity Index and Liquid Limit of fine aggregate.
- i. Percent fractured faces.
- j. Percent elongated particles.
- k. Anti-strip agent.

The Contractor shall submit samples to the DEN Project Manager, upon request, for job mix formula verification testing.

The combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation shown in Table 1 when tested in accordance with ASTM C 136 and ASTM C 117.

**405-3.3 Aggregate Gradation.** The aggregate shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradations specified in Table 2, when tested in accordance with ASTM Standards C 117 and C 136. The gradation shall be on the course side of the Master Band.

TABLE 1 – AGGREGATE – ASPHALT TREATED PERMEABLE BASE

Sieve Designation (Square Openings)	Job Mix Tolerances
1 ½ Inch	100
1 Inch	95-100
1/2 Inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-2

TABLE 1 – AGGREGATE – ASPHALT TREATED PERMEABLE BASE

Sieve Designation (Square Openings)	Job Mix Tolerances
Bituminous Cement	2.0-3.5% by weight of total mix

The gradation in Table 1 represents the limits which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 1 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from course to fine.

The gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves will be subject to appropriate adjustments when aggregates of varying specific gravities are used. The adjustments to the job mix gradation curve should result in a curve of the same general shape as the median curve of the gradation band in Table 1 and fall within the gradation band.

The Asphalt Institutes Manual Series No. 2 (MS-2) contains a convenient procedure for "adjusting" the job mix gradation when aggregates of non-uniform specific gravity are proposed for use.

The optimum percent bituminous cement for the ATPB shall be established in accordance with Innovative Pavement Research Foundation Report IPRF-01-G-002-02-1(G); Stabilized and Drainable Base for Rigid Pavement, Appendix C, section ATPB 3.2 Mix Design - which states the following:

"The Job Mix Formula (JMF) shall establish a single percentage of dry weight of aggregate passing each required sieve size, a single percentage of asphalt cement to be added to the aggregate based on the weights of the total mix, and a single temperature for the mixture as it is discharged into the hauling units. When tested in accordance with ASTM C136 & ASTM C117, the combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation specified in Table 1. The gradation band shown in Table 1 shall be applied to the JMF and used for job control. When the component aggregates are blended together, mixed with the specified amount of asphalt cement at a temperature of 250-degrees F, and compacted at 150-degrees F with 35 blows of a standard Marshall hammer, the JMF shall have a permeability of not less than 500 ft/day nor more than 1,500 ft/day when tested in accordance with ASTM D 2434/AASHTO T 215 (Constant Head Permeability Test). The JMF shall have a minimum asphalt binder content of 2.0 percent by weight, which can be adjusted upward to 3.5 percent to provide stability under rollers during construction and to meet the desired permeability requirements."

The job mix tolerances shown in Table 2 shall be applied to the job mix formula to establish a job control grading band. The full tolerances still will apply if application of the job mix tolerances results in job control grading band outside the master grading band.

TABLE 2 – JOB MIX FORMULA TOLERANCES (BASED ON A SINGLE TEST)

Material	Tolerance Plus or Minus
Aggregate Passing No. 4 Sieve or Larger	7 Percent
Aggregate Passing Numbers 8 and 16 Sieves	6 Percent
Aggregate Passing Numbers 30 and 50 Sieves	5 Percent
Aggregate Passing Numbers 100 and 200 Sieves	3 Percent
Bitumen Content (Individual Tests)	0.45 Percent
Bitumen Content (Moving Average of Last 5 Tests)	0.25 Percent Variation
Temperature of Mix*	20 <sup>o</sup> F
* Unless otherwise approved by the DEN Project Manager.	

The aggregate gradation may be adjusted within the limits of Table 1 as directed, without adjustments in the contract unit prices.

Should a change in sources of materials or differing components be made, a new job mix formula shall be established before the new material is used.

Deviation from the final approved design for bituminous content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extractions.

Dry aggregate gradations will be made at least twice daily. Extraction tests will be made twice daily, and the results averaged and analyzed as one test for the day's production.

The mixture shall be tested for bitumen content in accordance with ASTM D2172 or ASTM D6307 and for aggregate gradation in accordance with ASTM C136 and ASTM C117.

**405-3.4 Job Mix Formula (JMF) Laboratory.** The Contractor's laboratory used to develop the JMF shall be accredited in accordance with ASTM D3666. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the JMF must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the DEN Project Manager prior to start of construction.

**405-3.5 Test Section.** At least one full day prior to full production, the Contractor shall prepare a quantity of ATPB mixture according to the approved job mix formula. The amount of mixture should be sufficient to construct a test section at least 100 feet long BY 100 feet wide and of the same depth specified on the plans. The test area will be designated by the DEN PM or proposed by the Contractor and approved by the DEN PM. The underlying pavement on which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment to be used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. No bituminous mixture shall be produced for payment prior to successful placement of and acceptance of a test strip by the DEN PM.

For the ATPB, plant material and field cores will be taken to perform aggregate gradation, bitumen content, permeability, and temperature. Density and Marshall Stability Tests need not be performed. In no case will the plant-produced mix be considered acceptable if the mix properties of the test section do not meet the requirements of the mix design criteria.

If the test section should prove to be unsatisfactory, the necessary adjustments to plant operation, and/or placement procedures shall be made. Additional test sections, as required, shall be constructed, and evaluated for conformance to the specifications. When the test section does not conform to specification requirements the test section shall be removed and replaced at the Contractors expense. Full production shall not begin without approval of the DEN Project Manager. The asphalt content may be adjusted during the test section if deemed appropriate. Any successful adjustment shall be used as the target asphalt content.

### QUALITY CONTROL

**405-4.1 General.** The Contractor will provide and maintain a quality control system that will require the Contractor to provide reasonable assurance that all materials and completed construction submitted for acceptance conform to the Contract requirements whether manufactured or processed by the Contractor or procured from subcontractors or vendors.

A job mix shall be required by Section 405-3.02 of this specification prior to start of production, and whenever a change in materials warrants retesting.

**405-4.2 Quality Control Testing.** The Contractor shall be responsible to provide samples of bituminous and aggregate materials that are proposed for use. A statement for the proposed source and character of the materials shall also be submitted with the appropriate testing requirements for approval prior to use. The Contractor shall require the manufacturer or producer of the bituminous and aggregate materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials that have been tested and approved for the intended use shall be acceptable.

The Contractor shall furnish the vendor's certified test reports for each carload or equivalent of bituminous material shipped to the project. The report shall be delivered to the DEN PM before permission is granted to use the material. The vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All test reports shall be subject to verification by testing sample materials received for use on the project.

Extraction tests for bitumen content and aggregate gradation will be made at least twice daily. Sample aggregate for gradation in accordance with ASTM D 979 or D 75, as applicable. The mixture will be tested for bitumen content in strict conformance with ASTM D 2172, D 4125, or D 6307. If methods D 2172 or D 6307 are used, test aggregate for gradation in accordance with ASTM D 5444. If method D 4125 is used, test aggregate for gradation in accordance with ASTM C 136 and C 117.

### CONSTRUCTION METHODS

**405-5.1 Weather Limitations.** The mixture shall not be placed upon a wet surface or when the

surface temperature of the underlying course is less than specified in Table 4, or the chill factor is less than 35°F.

The date for computing the chill factor can be obtained from airport weather equipment or nearby radio stations and Table 5. If the haul distance for the asphaltic concrete is more than 15 miles, paving operations shall not be allowed after October 1 without written approval of the DIA Project Manager.

TABLE 3 – BASE TEMPERATURE LIMITATIONS

Mat Thickness	Base Temperatures (min.)	
	°F	°C
3 Inch (7.5 cm) or Greater	45	7
Greater Than 1 Inch (2.5 cm) But Less Than 3 Inches (7.5 cm)	50	10

TABLE 4 – WIND CHILL TABLE

Wind Speed MPH	Air Temperature °F			
	45	40	35	30
5	43	37	32	27
10	34	28	22	16
15	29	23	6	9
20	26	19	12	4

- a. **Other Limitations.** The excavation of this material is temperature and light sensitive. Due to this, methods of trenching and placing conduit shall be developed

**405-5.2 Bituminous Mixing Plant.** If the supplier is equipped with an automated plant, the automatic feature shall be used in the production of bituminous material for the project. If the supplier is equipped with a recording feature, it also shall be used. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. The storage area shall be neat and orderly, and the separate stockpiles shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (A) except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under (B), continuous mixing plants shall conform to the requirements under (C) and drum mixers shall conform to the requirements under (D).

- a. **Requirements for All Plants.** Mixing plants shall be of sufficient capacity to adequately

handle the proposed bituminous construction. The mixing plant shall have a minimum hourly production of 100 tons.

1. **Plant Scales.** Scales shall be accurate to 0.5 percent of the required load. Poises shall be designated to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales, the contractor may provide an approved automatic printer system to print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weight ticket for each load. Scales shall be inspected for accuracy and sealed as often as the DIA Project Manager may deem necessary. The Contractor shall have on hand not less than ten 50-pound weights for testing the scales.
2. **Equipment for Preparation of Bituminous Material.** Tanks for storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. Heating shall be accomplished by approved means so that flames will not contact the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring quantities and for sampling the material in the storage tanks.
3. **Cold Feeders.** The plant shall be provided with accurate mechanical or electrical means for uniformly feeding the aggregates into the drier to obtain uniform production and temperature. When added mineral filler is specified, a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders.
4. **Drier.** The plant shall include a drier(s) which continuously agitate the aggregate during the heating and drying process.
5. **Screens.** Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities more than the full capacity of the mixer, shall be provided. In states where the highway departments do not require hot bin screens, the screenless plant shall be permitted if the mix can be produced within the specification limits and tolerances. For the batch plant and continuous mix plants, gradation shall be taken on the aggregate without asphalt. This would be after the aggregate has been combined after passing through the dryer.

When drum mixers are used, the gradation test shall be made by the extraction method. Two extraction samples shall be taken, and the results combined, averaged, and analyzed as one test. After production has started and an acceptable correlation can be made between and hot combined aggregate samples and the cold feed samples, then only cold feed gradations shall be required; however, frequent checks shall be made.

6. **Bins.** The plant shall include storage bins, if required, of sufficient

capacity to supply a mixer operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. When used, separate dry storage shall be provided with overflow pipes of such size and at such location to prevent backup of material into other compartments or bins. Each compartment shall be provided with its own individual outlet gate to prevent leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples may be obtained readily. Bins shall be equipped with adequate telltale devices which indicate the position of the aggregates in the bins at the lower quarter points.

7. Bituminous Control Unit. Satisfactory means, either by weighing or metering shall be provided to obtain the specified amount of bituminous material in the mix. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.
8. Thermometric Equipment. An armored thermometer of adequate range shall be placed in the bituminous feed line at a suitable location near the charging valve of the mixer unit. The plant shall also be equipped with an approved thermometric instrument placed at the discharge chute of the drier to indicate the temperature of the heated aggregate. The DEN Project Manager may require replacement of any thermometer by an approved temperature recording apparatus for better regulation of the temperature of aggregates.
9. Dust Collector. The plant shall be equipped with a dust collector to waste any material collected. This equipment shall operate within the state EPA requirements.
10. Safety Requirements. Adequate and safe stairways to the mixer platform and sampling point shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a suitable device to enable the DEN Project Manager to obtain samples and mixture temperature data. Means shall be provided to raise and lower scale calibration equipment, sampling equipment, and other similar equipment between the ground and the mixer platform. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded. Ample and unobstructed passage shall be always maintained in and around the truck loading area. This area shall be kept free of drippings from the mixing platform.
11. Testing Laboratory. The Contractor or producer shall provide a testing laboratory for control testing functions during periods of mix production, sampling, and testing and whenever materials subject to provisions of these specifications are being supplied or tested. The Contractor shall equip the laboratory with tables, sinks, desks, and other required furniture and shall provide all utilities such as water and electricity for operation of the laboratory. The testing laboratory company shall be responsible for furnishing the actual testing equipment.

**b. Requirements for Batching Plants:**

1. Weigh Box or Hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.
- 2.
2. Bituminous Control. The equipment used to measure the bituminous material shall be accurate to within  $\pm 0.5$  percent. The bituminous material bucket shall be non-tilting type with a loose sheet metal cover. The length of the discharge opening, or spray bar shall be not less than three-fourths of the length of the mixer, and it shall discharge directly into the mixer. The bituminous material bucket discharge shall discharge directly into the mixer. The bituminous material bucket discharge valve (s), and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15% more than the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15% in excess of the quantity of bituminous material used in one batch. The controls shall be constructed to lock at any dial setting and automatically reset to that reading after the addition of each batch of bituminous material. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has begun. The size and spacing of the spray bar openings shall provide uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall have a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

3. Mixer. The batch mixer shall be of an approved type capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust. The clearance of blades from all fixed and moving parts shall not exceed 1 inch for surface course and 1 ½ inches for base course mixes.
4. Control of Mixing Time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall

lock mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening and the weigh box gate and the introduction of bituminous material. The wet mixing period is the interval of time between the introduction of bituminous material and the opening of the mixer gate.

The timing control shall be flexible and capable of setting of 5-second intervals or less throughout a 3-minute cycle. A mechanical batch counter shall be installed as a part of the timing device and shall be so designated to register only completely mixed batches.

The setting of time intervals shall be as directed by the Contactor's QC Manager. The case covering the timing device shall then be locked until a change is required in the timing periods.

**c. Requirements for Continuous Plants:**

1. Aggregate Proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means and provided with a lock.

Indicators shall be provided for each gate to show the respective gate opening in inches.

2. Weight Calibration of Aggregate Feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provisions shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples of not less than 200 pounds. Accurate scales shall be provided by the Contractor to weigh such test samples.
3. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control shall be by interlocking mechanical means or by any other positive method satisfactory to the DIA Project Manager.
4. Mixer. The plant shall include a continuous mixer of an approved type adequately heated and capable of producing a uniform mixture within the job mix tolerances. It shall be equipped with a discharge hopper with dump gates to permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular positioning on the shafts and shall

be reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed per minute for each aggregate used.

**d. Requirements for Drum Mixers.**

1. Exclusions. Paragraphs 4.02. (A.4 through A.9) do not apply to drum mixers.
2. Aggregate Delivery System. An automatic plant shutoff shall be provided to operate when any aggregate bin becomes empty. Provisions shall be provided for conveniently sampling the full flow of materials from each cold feed and the total cold feed. Total cold feed shall be weighed continuously. The weighing system shall have an accuracy of 0.5 percent when tested for accuracy. The plant shall provide positive weight control of the cold aggregate feed by use of a belt scale, or other appropriate device, which will automatically regulate the feed gate and permit instant correction of variations in load. The cold feed flow shall be automatically coupled with the asphalt flow to maintain the required proportions of each material. Provisions shall be made for introducing the moisture content of the cold feed aggregates into the belt weighing signal and correcting wet aggregate weight to dry aggregate weight. Screens or other suitable devices which will reject oversize particles or lumps of aggregate that have been cemented together shall be installed in the feeder mechanism between the bins and the dryer drum.

Dry weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time and totalized.

3. Bituminous Material and Additive Delivery Systems. Satisfactory means of metering shall be provided to introduce the proper amount of bituminous material and additives into the mix. Delivery systems shall prove accurate to plus or minus 1 percent when tested for accuracy. The bituminous material and additive delivery shall be interlocked with the aggregate weight. The bituminous material and additive flow shall be displayed digitally in appropriate units of volume (or weight) and time shall be totalized.
4. Thermometric Equipment. A recording thermometer of adequate range shall be located to indicate the temperature of the bituminous material in storage. The plant shall also be equipped with approved recording thermometers, pyrometers, or other approved recording thermometric instruments at the discharge chute of the drum mixer.
5. Drum Mixer. A drum mixer of satisfactory design shall be provided. It shall be capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the paving mixture requirements and capable of producing a uniform mixture. If the quality requirements of sub-item 404-3.01 cannot be met, the Contractor will be required to utilize

either batch or continuous mix plants.

- e. Inspection Plant. The DEN Project Manager or his authorized representative shall have access, at all times, to all parts of the paving plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.

**405-5.2 Hauling Equipment.** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. To prevent the mixture from adhering to them, the beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall be covered during the delivery of material from the plant to the lay-down machine. When it is necessary to prevent crusting at the surface or the sides or a loss in heat below the specified minimum temperature, the material shall be delivered in insulated truck beds.

**405-5.4 Bituminous Spreaders.** Bituminous material spreaders shall be the self-propelled type, equipped with hoppers, tamping or vibrating devices, distributing screws, adjustable screeds, equipment for heating the screeds, and equalizing devices. The spreader shall be capable of spreading hot bituminous mixtures without tearing, shoving, or gouging, and capable of producing a finished surface conforming to the smoothness requirements specified hereinafter. The spreader shall be capable of confining the edges of the strips to true lines without the use of stationary side forms, and of placing the course to the required thickness. Spreaders shall be designed to operate forward at variable speeds and in reverse at traveling speeds of not less than 100 feet per minute. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh-laid mix during operation will not be permitted. The paver shall not damage the underlying course. The Contractor shall keep the paver in good operational condition at all times. If extensions are used, they shall contain the same vibration and screed heater equipment as the basic paver. This does not apply when extensions are used for fillet construction. Bituminous material spreaders shall be equipped with electronic sensing devices for grade control. The devices shall be capable of utilizing the string line long-ski sled, and automatic transverse grade control methods for controlling grades. The long-ski sled shall have a minimum length of 25 feet. The controls shall be so arranged that independent longitudinal grade controls can be operated simultaneously on both sides of the machine or independently on either side. The electronic controls shall be arranged so that the machine can be controlled automatically, semi-automatically, or manually.

**405-5.5 Rollers.** Rollers will be tandem, steel-wheeled rollers weighing between 6 and 10 tons. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture as directed by the DEN Project Manager.

**405-5.6 Preparation of Bituminous Material.** The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of bituminous material to the mixer at a uniform temperature.

**405-5.7 Preparation of Mineral Aggregate.** The aggregate for the mixture shall be dried and heated at the central mixing plant before entering the mixer. When introduced into the mixer,

the combined aggregate moisture content (weighted according to the composition of the blend) shall be less than 0.25 percent for aggregate blends with water absorption of 2.5 percent or less and less than 0.50 percent for aggregate blends with water absorption greater than 2.5 percent. Water absorption of aggregates shall be determined by ASTM C 127 and C 128. The water absorption for the aggregate blend shall be the weighted average of the absorption values for the coarse aggregate retained on the No. 4 sieve (4.75 mm) and the fine aggregate passing the No. 4 sieve (4.75 mm). The water content test will be conducted in accordance with ASTM C 566. In no case shall the moisture content be such that foaming of the mixture occurs prior to placement. At the time of mixing, the temperature of the aggregate shall be within the range specified in the job mix formula. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. Particular care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The aggregate shall be screened to specified sizes and conveyed in separate bins ready for mixing with bituminous material. The use of a drum mix plant may be approved provided that the limitations in moisture and temperature are adhered to.

In no case shall the temperature of the aggregate be more than 25°F above the temperature of the bituminous material. Mixing shall continue until all particles are coated uniformly.

**405-5.8 Preparation of Bituminous Mixture.** The aggregates and the bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate are secured. Wet mixing time shall be approved by the DEN Project Manager for each plant and for each type of aggregate used. Normally, the mixing time after introduction of bituminous material should not be less than 30 seconds. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per seconds by the mixer.

$$\text{Mixing Time (Seconds)} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

The dry mixing time in the batch plant shall be the time required to blend the dry aggregate in uniform mixture. The wet mixing time begins with the introduction of the asphalt cement to the pugmill and ends with the opening of the discharge gate.

Prolonged exposure to air and heat in the pugmill hardens the asphalt film on the aggregate through oxidation. Therefore, the mixing time should be the shortest time required to obtain uniform distribution of aggregate sizes and thorough coating of aggregate particles with the bituminous material.

In no case shall the bituminous mixture be stored in storage silos or surge bins.

**405-5.9 Transporting, Spreading and Finishing.** The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Section 4.03.

Deliveries shall be scheduled so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight unless adequate artificial lighting is provided. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to ambient temperatures or for eight hours, whichever is longer.

Immediately before placing the bituminous mixture, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed.

Upon arrival, the mixture shall be spread to the full width by an approved bituminous paver. The mixture shall be placed at a temperature of not less than 2500F. It shall be struck off in uniform layer of such depth that, when the work is completed, it shall have a minimum thickness of 3 inches and no more than 4.5 inches per lift. The required thickness of the initial course shall be constructed to conform to the grade and contours indicated on the plans. The minimum total thickness required is 4 inches in the GSE pavement area and 6 inches in the Aircraft Apron pavement area. Excessive waiting or delay in placement at the job site shall not be allowed and the mix found to be outside of the specified temperature range will not be accepted. Bleeding and rich spots resulting from segregation during transportation shall not be accepted.

Unless otherwise directed, placing shall begin along the highest elevation areas to be paved and proceed to the lower elevation areas. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet, except where edge lanes require strips less than 10 feet to complete the area. The longitudinal joint in one layer shall offset that in the layer immediately below by at least 1 foot. Transverse joints in one layer shall be offset by at least 2 feet from transverse joints in the previous layer (at the phase limits).

The responsible party shall set grade requirements for each paving lane.

After the first lane of each lift is constructed, a joint matcher (short-ski) shall be used on the previous laid lane. The free edge shall be controlled as specified hereinbefore.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mix may be spread, raked, and luted by hand tools.

**405-5.10 Compaction of Mixture.** After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Approximately 2 or 3 complete passes should be sufficient to compact the mixture. Rolling will be withheld until the mixture has cooled between 150°F to 175°F. Rolling of the mixture shall be performed in accordance with the approved test section. Rolling shall be initiated with the drive wheel toward the paving machine. The sequence of rolling for the first paving lane should be to first roll the lower edge (with reference to the transverse slope) of the lane and then roll the upper edge. The interior of the lane should then be rolled from the lower side toward the upper with overlapping roller paths. On adjoining paving lanes, rolling shall begin by overlapping the joint (with the previous lane) by 6 to 8 inches and then rolling the outside edge of the new lane. The interior is rolled from the outside edge toward the compacted joints with overlapping wheel paths. Alternate paths of the roller shall be of slightly different lengths.

The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture. The rollers shall not travel faster than 3 MPH. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and fresh mixture. The roller shall not be permitted to stand static on the hot material.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture and true to grade and cross section, no movement of the mixture can be noticed, and no roller marks are on the surface.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened; however, excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt or in any way defective shall be removed and placed with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Spreading of the mixture shall be done carefully with particular attention given to making the operation as continuous as possible. Hand working shall be kept to an absolute minimum.

Skin patching and hand working of the ATPB mixture will not be allowed.

**405-5.11 Joints.** The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.

The joints between old and new pavements or between successive day's work or between phases, or joints that have become cold because of any delay, shall be carefully made in such manner as to insure a continuous bond between old and new sections of the course. All contact surfaces of previously constructed pavements that have become coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back with an approved power saw, as directed. The faces of these joints shall be painted with a thin coat of tack conforming to P-603.

When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. The joint shall be rolled perpendicular to the paving lane with the roller overlapping the new material approximately one foot. Boards or other devices shall be placed on the edges of the paving lane to prevent roll down of the edges.

All joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean sound surface for the full depth of the course.

**405-5.12 Surface Tests.** Tests for conformity with the specified slope and grade shall be made by the Contractor's Quality Control personnel immediately after initial compaction. Any variation shall be corrected by the removal or addition of material and by continuous rolling. Unless otherwise specified in writing, the Contractor shall provide a 12-foot straightedge on the job at all times.

After the completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected. All corrective work shall be done at the Contractor's expense. The finished surface shall not vary more than ½ inch when tested with a 12-foot straightedge applied parallel with, and/or at right angles to the

paving lane direction; and shall not vary from the grade line, elevations, and cross sections shown on the contract drawings by more than ½ inch. Verification of final grades shall be by survey on a 20-foot grid. The Contractor shall correct areas varying in excess of this amount by removing and replacing defective work when directed by the DEN Project Manager.

**405-5.13 Maintenance.** The completed drainage layer shall be maintained by the Contractor in a condition to meet all specification requirements until the PCC pavement has been placed.

## **MATERIAL ACCEPTANCE**

**405-6.1 Acceptance Testing.** The DEN Project Manager, at no cost to the Contractor, shall perform all acceptance sampling and testing. Approval and continued acceptance of a satisfactory mix shall be based on the following:

Field samples of the ATPB mixture shall be taken at the point of discharge in hauling units and tested to control uniformity in bituminous content and gradation. Samples shall be taken in accordance with ASTM D 979 and prepared in accordance with ASTM D 2172 or ASTM D 6307. One sample shall be taken from each lot on a random basis in accordance with procedures contained in ASTM D 3665. A lot shall consist of 1,000 tons or 1/2 day's production, whichever is less. Should the average bituminous content for any two consecutive lots not fall within job mix tolerances indicated in Table 2, the Contractor shall cease production until such out-of-tolerance conditions have been remedied. Any material, placed after the contractor has been informed of two consecutive failing tests, shall be rejected and removed at the Contractor's expense. A/C content will be determined by calibrated extraction oven in accordance with ASTM D 6307. The Contractor will provide samples, as required, for proper oven calibration.

Aggregate from each hot bin or aggregate feed shall be sampled on a random basis and tested for gradation analysis in accordance with ASTM C136 and ASTM C117. One sample shall be taken on a random basis in accordance with ASTM D 3665 for each lot. A lot shall consist of 500 tons or 1/4 day's production, whichever is less. If any two consecutive samples fail to meet the tolerances of the job mix formula gradation, the Contractor shall cease plant production until such out of tolerance conditions have been remedied. Any material, placed after the contractor has been informed of two consecutive failing tests, shall be rejected and removed at the Contractor's expense.

Completed ATPB shall be determined "acceptable" or "unacceptable" on the basis of visual inspection by the DEN PM. The DEN PM will notify the Contractor of unsatisfactory visual defects in the completed bituminous base course such as non-uniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture during the roller operations, or nonconformance to the surface smoothness criteria specified. Unsatisfactory ATPB shall be removed and replaced at the Contractor's expense as directed by the DEN PM.

"Unacceptable" ATPB shall be removed, leaving a vertical face at the remaining ATPB. The underlying surface shall be cleaned, and a tack coat applied prior to replacing the ATPB. Such rework shall be at the Contractor's expense. Unacceptable ATPB shall not be measured for payment.

Should gradation analysis or A/C content fail to meet the tolerances of the job mix formula, the

DEN PM may order another analysis in addition to the two analyses required each day to confirm the results of the previous tests, or tell the Contractor to cease plant production until such out-of-tolerance conditions have been corrected.

Thickness of ATPB shall be evaluated by the DEN PM for compliance to the requirements shown on the plans. To determine the thickness of the finished ATPB, the DEN PM shall take one core sample, not less than 2 inches (5 cm) in diameter, at random from each unit of the completed ATPB area. A unit of the completed area shall be one paving lane wide by prescribed length of the phase.

When the measurement of any core is less than the minimum allowable thickness, as shown in Table 6, additional cores shall be taken at 20-foot intervals (parallel to and at right angles to the paving lane) until the completed ATPB is within such minimum thickness for the subunit being tested. Out-of-tolerance areas shall be repaired at the Contractor's cost. If the average of the area in question is below the minimum thickness requirement, the area shall be reviewed for payment adjustment or repaired to meet the minimum thickness requirement.

**TABLE 5 – ALLOWABLE FINISHED ATPB THICKNESS**

Area	Minimum (in.)
GSE Pavement Area	4.0
Bitumen*	0.40 Percent
Aircraft Apron Pavement Area	6.0

## **METHOD OF MEASUREMENT**

### **405-7.1 Measurement**

Asphalt Treated Permeable Base (ATPB) Course shall be measured by the number of square yards as specified in-place, complete and accepted by the DEN Project Manager.

## **BASIS OF PAYMENT**

### **405-8.1 PAYMENT**

Payment for accepted Asphalt Treated Permeable Base (ATPB) Course shall be made at the full or adjusted contract unit price per square yard. This price shall be full compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Item P-405-8.1 Asphalt Treated Permeable Base Course (5 - 7 Inches) - per square yard

## **TESTING REQUIREMENTS**

ASTM D 75	Sampling Aggregates
ASTM C 33	Concrete Aggregate
ASTM C 88	Soundness of Aggregates by Use of Sodium or Magnesium Sulfate
ASTM C 117	Materials Finer than No. 200, Sieve in Mineral Aggregates by Washing
ASTM C 127	Density, Specific Gravity and Absorption of Coarse Aggregates
ASTM C 128	Density, Specific Gravity, and Absorption of Fine Aggregate
ASTM C 131	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates (Dry)
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM C 566	Total Evaporable Moisture Content of Aggregate by Drying
ASTM D 693	Crushed Aggregate for Macadam Pavements
ASTM D 979	Sampling Bituminous Paving Mixtures
ASTM D 995	Mixing Plants for Hot-Mixed Hot-Laid Bituminous Paving Mixtures
ASTM D 2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2434	Constant Head Permeability Test
ASTM D 2741	Susceptibility of Polyethylene Bottles to Soot Accumulation
ASTM D 3665	Random Sampling of Paving Materials
ASTM D 3666	Minimum Requirements for Agencies Testing and

	Inspecting Bituminous Paving Materials
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder
ASTM D 6926	Preparation of Bituminous Specimens Using MARSHALL Apparatus

**END OF SECTION P-405**

## Item P-501 Cement Concrete Pavement

### DESCRIPTION

**501-1.1** This work shall consist of pavement composed of cement concrete with reinforcement and without reinforcement constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans. The terms cement concrete, hydraulic cement concrete, and concrete are interchangeable in this specification.

### MATERIALS

#### 501-2.1 Aggregates.

**a. Reactivity.** Fine and Coarse aggregates to be used in PCC on this project shall be tested and evaluated by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Tests must be representative of aggregate sources which will be providing material for production. ASTM C1260 and ASTM C1567 tests may be run concurrently.

(1) Coarse aggregate and fine aggregate shall be tested separately in accordance with ASTM C1260, however, the length of test shall be extended to 28 days (30 days from casting). Tests must have been completed within 6 months of the date of the concrete mix submittal.

(2) The combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

(3) If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662 in lieu of ASTM C1567. If lithium nitrate admixture is used, it shall be nominal 30%  $\pm$ 0.5% weight lithium nitrate in water. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

**b. Fine aggregate.** Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and the parameters identified in the fine aggregate material requirements below. Fine aggregate material requirements and deleterious limits are shown in the table below.

**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-501 CEMENT CONCRETE PAVEMENT**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

<b>Fine Aggregate Material Requirements</b>		
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Sand Equivalent	45 minimum	ASTM D2419
Fineness Modulus (FM)	$2.50 \leq FM \leq 3.40$	ASTM C136
<b>Limits for Deleterious Substances in Fine Aggregate for Concrete</b>		
Clay lumps and friable particles	1.0% maximum	ASTM C142
Coal and lignite	0.5% using a medium with a density of Sp. Gr. of 2.0	ASTM C123
Total Deleterious Material	1.0% maximum	

**c. Coarse aggregate.** The maximum size coarse aggregate shall be 1-1/2 inch.

Aggregates delivered to the mixer shall be clean, hard, uncoated aggregates consisting of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates shall have no known history of detrimental pavement staining. Steel blast furnace slag shall not be permitted. Coarse aggregate material requirements and deleterious limits are shown in the table below; washing may be required to meet aggregate requirements.

**Coarse Aggregate Material Requirements**

<b>Material Test</b>	<b>Requirement</b>	<b>Standard</b>
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 for any size group coarser than 3/8 (9.5 mm) sieve <sup>1</sup>	ASTM D4791
Bulk density of slag <sup>2</sup>	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29
D-cracking (Freeze-Thaw) <sup>3</sup>	Durability factor $\geq 95$	ASTM C666

<sup>1</sup> A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

<sup>2</sup> Only required if slag is specified.

<sup>3</sup> Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not

have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

#### Limits for Deleterious Substances in Coarse Aggregate

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (75 µm)	ASTM C117	1.0 <sup>1</sup>
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert <sup>2</sup> (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	0.1 <sup>3</sup>

<sup>1</sup> The limit for material finer than 75-µm is allowed to be increased to 1.5% for crushed aggregates consisting of dust of fracture that is essentially free from clay or shale. Test results supporting acceptance of increasing limit to 1.5% with statement indicating material is dust of fracture must be submitted with Concrete mix. Acceptable techniques to characterizing these fines include methylene blue adsorption or X-ray diffraction analysis.

<sup>2</sup> Chert and aggregates with less than 2.4 specific gravity.

<sup>3</sup> The limit for chert may be increased to 1.0 percent by mass in areas not subject to severe freeze and thaw.

**d. Combined aggregate gradation.** This specification is targeted for a combined aggregate gradation developed following the guidance presented in United States Air Force Engineering Technical Letter (ETL) 97-5: Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements. Base the aggregate grading upon a combination of all the aggregates (coarse and fine) to be used for the mixture proportioning. Three aggregate sizes may be required to achieve an optimized combined gradation that will produce a workable concrete mixture for its intended use. Use aggregate gradations that produce concrete mixtures with well-graded or optimized aggregate combinations. The Contractor shall submit complete mixture information necessary to calculate the volumetric components of the mixture. The combined aggregate grading shall meet the following requirements:

(1) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in paragraph 501-2.1d(4) below, the point thus determined shall fall within the parallelogram described therein.

(2) The CF shall be determined from the following equation:

$$CF = \frac{\text{(cumulative percent retained on the 3/8 in. (9.5 mm) sieve)}(100)}{\text{(cumulative percent retained on the No. 8 (2.36 mm) sieve)}}$$

(3) The WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).

(4) A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary. The point determined by the plotting of the CF and WF may be adjusted during production  $\pm 3$  WF and  $\pm 5$  CF. Adjustments to gradation may not take the point outside of the parallelogram.

**e. Contractors combined aggregate gradation.** The Contractor shall submit their combined aggregate gradation using the following format:

**Contractor's Combined Aggregate Gradation**

Sieve Size	Contractor's Concrete mix Gradation (Percent passing by weight)
2 inch (50 mm)	*
1-1/2 inch (37.5 mm)	*
1 inch (25.0 mm)	*
3/4 inch (19.0 mm)	*
1/2 inch (12.5 mm)	*
3/8 inch (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 16 (1.18 mm)	*
No. 30 (600 $\mu$ m)	*
No. 50 (300 $\mu$ m)	*
No. 100 (150 $\mu$ m)	*

**501-2.2 Cement.** Cement shall conform to the requirements of ASTM C150 Type I, II, or V or ASTM C595 Type IP or IL.

**501-2.3 Cementitious materials.**

**a. Fly ash.** Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total alkali content less than 3% per ASTM C311. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as

they become available during the project. The reports can be used for acceptance or the material may be tested independently by the DEN Project Manager (DEN PM).

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

**c. Raw or calcined natural pozzolan.** Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

**501-2.4 Joint seal.** The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-604 and Item P-605, whichever is applicable, and shall be of the type specified in the plans.

**501-2.5 Isolation joint filler.** Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1751 or ASTM D1752 and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the DEN PM. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the DEN PM.

**501-2.6 Steel reinforcement.** Reinforcing shall consist of epoxy-coated steel wire and welded wire reinforcement conforming to the requirements of ASTM A884. Welded wire fabrics shall be furnished in flat sheets only..

**501-2.7 Dowel and tie bars.** Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete.

**a. Dowel Bars.** Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078, Type 1, with a coating thickness after curing greater than 10 mils. Patched ends are not required for Type 1 coated dowels. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

**b. Tie Bars.** Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

**501-2.8 Water.** Water used in mixing or curing shall be potable. If water is taken from other sources considered non-potable, it shall meet the requirements of ASTM C1602.

**501-2.9 Material for curing concrete.** Curing materials shall conform to one of the following specifications:

**a.** Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class A, or Class B.

**b.** White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

**c.** White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

**d.** Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

**501-2.10 Admixtures.** Admixtures shall conform to the following specifications:

**a. Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entraining agent and any water reducer admixture shall be compatible.

**b. Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D.

**c. Other admixtures.** The use of set retarding and set-accelerating admixtures shall be approved by the DEN PM prior to developing the concrete mix. Retarding admixtures shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating admixtures shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

**d. Lithium Nitrate.** The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

**Lithium Admixture**

Constituent	Limit (Percent by Mass)
LiNO <sub>3</sub> (Lithium Nitrate)	30 ±0.5
SO <sub>4</sub> (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium nitrate admixture dispensing and mixing operations shall be verified and certified by the lithium manufacturer's representative.

**501-2.11 Epoxy-resin.** All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

**a.** Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

**b.** Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

**c.** Material for use for injecting cracks shall be Type IV, Grade 1.

**d.** Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

**501-2.12 Bond Breaker.** Fabric shall meet the requirements of AASHTO M 288 Class I fabric with elongation not less than 50% at the specified strengths, with a weight not less than 14.5 oz/sy. A certificate of compliance (COC) shall be provided by the fabric manufacturer that the material may be used as a bond breaker.

## CONCRETE MIX

**501-3.1. General.** No concrete shall be placed until an acceptable concrete mix has been submitted to the DEN PM for review and the DEN PM has taken appropriate action. The DEN PM's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

**501-3.2 Concrete Mix Laboratory.** The laboratory used to develop the concrete mix shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix must be included in the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the DEN PM prior to start of construction.

**501-3.3 Concrete Mix Proportions.** Develop the mix using the procedures contained in Portland Cement Association (PCA) publication, "Design and Control of Concrete Mixtures." Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-6.6 for a flexural strength of **700 psi** per ASTM C78.

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be **517 pounds per cubic yard**. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be between 0.38 – 0.45 by weight.

Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. At the start of the project, the Contractor shall determine an allowable slump as determined by ASTM C143 not to exceed 2 inches (50 mm) for slip-form placement. For fixed-form placement, the slump shall not exceed 3 inches (75 mm). For hand placement, the slump shall not exceed 4 inches (100 mm).

The results of the concrete mix shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

If a change in source(s) is made, or admixtures added or deleted from the mix, a new concrete mix must be submitted to the DEN PM for approval.

The DEN PM may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

**501-3.4 Concrete Mix submittal.** The concrete mix shall be submitted to the DEN PM at least 30 days prior to the start of operations. The submitted concrete mix shall not be more than 180 days old and must use the materials to be used for production for the project. Production shall not begin until the concrete mix is approved in writing by the DEN PM.

Each of the submitted concrete mixes (i.e, slip form, side form machine finish and side form hand finish) shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items and quantities as a minimum:

- Certified material test reports for aggregate in accordance with paragraph 501-2.1. Certified reports must include all tests required; reporting each test, test method, test result, and requirement specified (criteria).
- Combined aggregate gradations and analysis; and including plots of the fine aggregate fineness modulus.
- Reactivity Test Results.
- Coarse aggregate quality test results, including deleterious materials.
- Fine aggregate quality test results, including deleterious materials.
- Mill certificates for cement and supplemental cementitious materials.
- Certified test results for all admixtures, including Lithium Nitrate if applicable.
- Specified flexural strength, slump, and air content.
- Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
- Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- Correlation ratios for acceptance testing and Contractor QC testing, when applicable.
- Historical record of test results documenting production standard deviation, when applicable.

### **501-3.5 Cementitious materials.**

**a. Fly ash.** When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight.

**c. Raw or calcined natural pozzolan.** Natural pozzolan may be used in the concrete mix. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

### **501-3.6 Admixtures.**

**a. Air-entraining admixtures.** Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be **5.5%**. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

**b. Water-reducing admixtures.** Water-reducing admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the

specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

**c. Other admixtures.** Set controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

**d. Lithium nitrate.** Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10d.

## **CONSTRUCTION METHODS**

**501-4.1 Control Strip.** The control strip(s) shall be to the next planned joint after the initial 250 feet (75 m) of each type of pavement construction (slip-form pilot lane, slip-form fill-in lane, or fixed form). The Contractor shall demonstrate, in the presence of the DEN PM, that the materials, concrete mix, equipment, construction processes, and quality control processes meet the requirements of the specifications. The concrete mixture shall be extruded from the paver meeting the edge slump tolerance and with little or no finishing. Pilot, fill-in, and fixed-form control strips will be accepted separately. Minor adjustments to the mix design may be required to place an acceptable control strip. The production mix will be the adjusted mix design used to place the acceptable control strip. Upon acceptance of the control strip by the DEN PM, the Contractor must use the same equipment, materials, and construction methods for the remainder of concrete paving. Any adjustments to processes or materials must be approved in advance by the DEN PM. Acceptable control strips will meet edge slump tolerance and surface acceptable with little or no finishing, air content within action limits, strength equal or greater than requirements of P501-3.3. The control strip will be considered one lot for payment (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 501-8.1 using a lot pay factor equal to 100.

**501-4.2 Equipment.** The Contractor is responsible for the proper operation and maintenance of all equipment necessary for handling materials and performing all parts of the work to meet this specification.

**a. Plant and equipment.** The plant and mixing equipment shall conform to the requirements of ASTM C94 and/or ASTM C685. Each truck mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades. The truck mixers shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

Equipment for transferring and spreading concrete from the transporting equipment to the paving lane in front of the finishing equipment shall be provided. The equipment shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

**b. Finishing equipment.**

**(1) Slip-form.** The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements.

**(2) Fixed-form.** On projects requiring less than 10,000 cubic yards of concrete pavement or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with equipment specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the DEN PM. Hand screeding and float finishing may only be used on small irregular areas as allowed by the DEN PM.

**c. Vibrators.** Vibrator shall be the internal type. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation or voids. The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309R, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the DEN PM.

Hand held vibrators may only be used in irregular areas and shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

**d. Concrete saws.** The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

**e. Fixed forms.** Straight side fixed forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the DEN PM. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the DEN PM. The forms shall extend the full depth of the pavement section.

**501-4.3 Form setting.** Forms shall be set to line and grade as shown on the plans, sufficiently in advance of the concrete placement, to ensure continuous paving operation. Forms shall be set to withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the concrete placement.

**501-4.4 Base surface preparation prior to placement.** Any damage to the prepared base, subbase, and subgrade shall be corrected full depth by the Contractor prior to concrete placement. The underlying surface shall be entirely free of frost when concrete is placed. The prepared grade shall be moistened with water, without saturating, immediately ahead of

concrete placement to prevent rapid loss of moisture from concrete. Bond breaker shall be applied in accordance with 501-2.12.

**501-4.5 Handling, measuring, and batching material.** Aggregate stockpiles shall be constructed and managed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Store and maintain all aggregates at a uniform moisture content prior to use. A continuous supply of materials shall be provided to the work to ensure continuous placement.

A copy of the proposed batch ticket shall be submitted to the DEN Project Manager for approval. Batch tickets shall include as a minimum the information required in ASTM C94. Two copies of the batch tickets shall also be provided to the DEN Project Manager or his representative for each batch of concrete prior to unloading at the site.

**501-4.6 Mixing concrete.** The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are placed into the drum until the drum is emptied into the truck. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94 or ASTM C685.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is discharged from the truck should not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. In no case shall the temperature of the concrete when placed exceed 90°F (32°C). Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified is not exceeded.

**501-4.7 Weather Limitations on mixing and placing.** No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

**a. Cold weather.** Unless authorized in writing by the DEN PM, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

Curing during cold weather shall be in accordance with paragraph 501-4.13d.

**b. Hot weather.** During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The concrete placement shall be protected from exceeding an evaporation rate of 0.2 psf (0.98 kg/m<sup>2</sup> per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. If the Contractor's measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

Curing during hot weather shall be in accordance with paragraph 501-4.13e.

**c. Temperature management program.** Prior to the start of paving operation for each day of paving, the Contractor shall provide the DEN PM with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. (Federal Highway Administration HIPERPAV 3 is one example of a temperature management program.) As a minimum, the program shall address the following items:

(1) Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

(2) Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 19-9, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

**d. Rain.** The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

**501-4.8 Concrete Placement.** At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi, based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. The Contractor must determine that the above minimum strengths are adequate to protection the pavement from overloads due to the construction equipment proposed for the project.

**a. Slip-form construction.** The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without, segregation, voids, or vibrator trails and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude should be adjusted proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

Not more than 15% of the total free edge of each 500-foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge.

When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump will be removed the full width of the slip form lane and replaced at the expense of the Contractor as directed by the DEN PM.

**b. Fixed-form construction.** Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars / dowel bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and coated with a release agent each time they are used and before concrete is placed against them.

Concrete shall be spread, screed, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery. The equipment must be specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the DEN PM.

Concrete for the full paving width shall be effectively consolidated by internal vibrators. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation, voids, or leaving vibrator trails.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

**c. Consolidation.** Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 2 inches (50 mm). Vibrators shall not be used to transport or spread the concrete. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) or over-consolidation (vibrator trails, segregation, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the DEN PM.

If a lack of consolidation of the hardened concrete is suspected by the DEN PM, referee testing may be required. Referee testing of hardened concrete will be performed by the DEN PM by cutting cores from the finished pavement after a minimum of 24 hours curing. The DEN PM shall visually examine the cores for evidence of lack of consolidation. Density determinations will be made by the DEN PM based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m<sup>2</sup>) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original concrete mix density, with no cores having a density of less than 96% of the original concrete mix density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the

effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

**501-4.9 Strike-off of concrete and placement of reinforcement.** Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screed. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

**501-4.10 Joints.** Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2-inch (12 mm) from their designated position and shall be true to line with not more than 1/4-inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12-foot (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

**a. Construction.** Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

**b. Contraction.** Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

**c. Isolation (expansion).** Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width

of the slab at the joint. The filler shall be fastened uniformly along the hardened joint face with no buckling or debris between the filler and the concrete interface, including a temporary filler for the sealant reservoir at the top of the slab. The edges of the joint shall be finished and tooled while the concrete is still plastic

#### **d. Dowels and Tie Bars for Joints**

**(1) Tie bars.** Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth and within the tolerances in paragraph 501-4.10(f.). When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.

**(2) Dowel bars.** Dowel bars shall be placed across joints in the proper horizontal and vertical alignment as shown on the plans. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the DEN PM. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

**(3) Placing dowels and tie bars.** Horizontal spacing of dowels shall be within a tolerance of  $\pm 3/4$  inch (19 mm). The vertical location on the face of the slab shall be within a tolerance of  $\pm 1/2$  inch (12 mm). The method used to install dowels shall ensure that the horizontal and vertical alignment will not be greater than 1/4 inch per feet (6 mm per 0.3 m), except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

**(a) Contraction joints.** Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

At the Contractor's option, dowels and tie bars in contraction joints may be installed by insertion into the plastic concrete using approved equipment and procedures per the paver manufacturer's design. Approval of installation methods will be based on the results of the control strip showing that the dowels and tie bars are installed within specified tolerances as verified by cores or non-destructive rebar location devices approved by the DEN PM.

**(b) Construction joints.** Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms.

**(c) Joints in hardened concrete.** Install dowels in hardened concrete by bonding the dowels into holes drilled into the concrete. The concrete shall have cured for seven (7) days or reached a minimum flexural strength of 450 psi before drilling begins. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does

not occur. Spalling beyond the limits of the grout retention ring will require modification of the equipment and operation. Depth of dowel hole shall be within a tolerance of  $\pm 1/2$  inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole by means of a suitable metal or plastic grout retention ring fitted around the dowel.

**e. Sawing of joints.** Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial saw-cut and maintained for the remaining cure period.

Joints shall be cut in locations as shown on the plans. The initial joint cut shall be a minimum  $1/8$  inch (3 mm) wide and to the depth shown on the plans. Prior to placement of joint sealant or seals, the top of the joint shall be widened by sawing as shown on the plans.

**501-4.11 Finishing.** Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, edging of joints, and then texturing. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Equipment, mixture, and/or procedures which produce more than  $1/4$  inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way. Fog (mist) sprays or other surface applied finishing aids specified to prevent plastic shrinkage cracking, approved by the DEN PM, may be used in accordance with the manufacturers requirements.

**a. Machine finishing with slipform pavers.** The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. Equipment, mixture, and/or procedures which produce more than  $1/4$  inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Remove excessive slurry from the surface with a cutting straightedge and wipe off the edge. Any slurry which does run down the vertical edges shall be immediately removed by hand, using

stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

**b. Machine finishing with fixed forms.** The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

**c. Other types of finishing equipment.** Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the DEN PM's approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

**d. Hand finishing.** Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical.

**e. Straightedge testing and surface correction.** After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a 12-foot (3.7-m) finishing straightedge swung from handles capable of spanning at least one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

**501-4.12 Surface texture.** The surface of the pavement shall be finished as designated below for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. The texture shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the DEN PM.

**a. Brush or broom finish.** If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 inch in depth.

**b. Burlap drag finish.** If a burlap drag is used to texture the pavement surface, the burlap of at least 15 ounces per square yard will typically produce acceptable texture. To obtain a

textured surface, the transverse threads of the burlap shall be removed approximately one foot from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface.

**c. Artificial turf finish.** Not used.

**501-4.13 Curing.** Immediately after finishing operations are completed and bleed water is gone from the surface, all exposed surfaces of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-saw-cut method is used to construct the contraction joint, the curing compound shall be applied to the saw-cut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

**a. Impervious membrane method.** Curing with liquid membrane compounds should not occur until bleed and surface moisture has evaporated. All exposed surfaces of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 square feet (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the DEN PM, a double application rate shall be used to ensure coverage. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

**b. White burlap-polyethylene sheets.** The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

**c. Water method.** The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

**d. Concrete protection for cold weather.** Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for

the remainder of the 7-day curing period. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

**e. Concrete protection for hot weather.** Concrete should be continuous moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the DEN PM.

**501-4.14 Removing forms.** Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured in accordance with paragraph 501-4.13.

If honeycombed areas are evident when the forms are removed, materials, placement, and consolidation methods must be reviewed and appropriate adjustments made to assure adequate consolidation at the edges of future concrete placements. Honeycombed areas that extend into the slab less than approximately 1 inch (25 mm), shall be repaired with an approved grout, as directed by the DEN PM. Honeycombed areas that extend into the slab greater than a depth of 1 inch (25 mm) shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-4.19.

**501-4.15 Saw-cut grooving.** If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

**501-4.16 Sealing joints.** The joints in the pavement shall be sealed in accordance with Item P-604, P-604A and P-605.

**501-4.17 Protection of pavement.** The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until accepted by the DEN PM. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the DEN PM.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days, the joints are protected, the concrete has attained a minimum field cured flexural strength of 450 psi, and the slab edge is protected.

All new and existing pavement carrying construction traffic or equipment shall be kept clean and spillage of concrete and other materials shall be cleaned up immediately.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

**501-4.18 Opening to construction traffic.** The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural

strength of 450 pounds per square inch when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

**501-4.19 Repair, removal, or replacement of slabs.** New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable as defined by acceptance criteria in paragraph 501-6.6 shall be removed and replaced or repaired, as directed by the DEN PM, at the Contractor's expense. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The DEN PM will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall have a diameter of 2 inches (50 mm) to 4 inches (100 mm), shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with a bonding agent, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. Repair of cracks as described in this section shall not be allowed if in the opinion of the DEN PM the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

**a. Shrinkage cracks.** Shrinkage cracks which do not exceed one-third of the pavement depth shall be cleaned and either high molecular weight methacrylate (HMWM) applied; or epoxy resin (Type IV, Grade 1) pressure injected using procedures recommended by the manufacturer and approved by the DEN PM. Sandblasting of the surface may be required following the application of HMWM to restore skid resistance. Care shall be taken to ensure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the DEN PM. Shrinkage cracks which exceed one-third the pavement depth shall be treated as full depth cracks in accordance with paragraphs 501-4.19b and 501-19c.

**b. Slabs with cracks through interior areas.** Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than one-third the pavement depth, that extend into the interior area.

**c. Cracks close to and parallel to joints.** All full-depth cracks within 6 inches (150 mm) either side of the joint and essentially parallel to the original joints, shall be treated as follows.

**(1) Full depth cracks and original joint not cracked.** The full-depth crack shall be treated as the new joint and the original joint filled with an epoxy resin.

**i. Full-depth crack.** The joint sealant reservoir for the crack shall be formed by sawing to a depth of 3/4 inches (19 mm),  $\pm 1/16$  inch (2 mm), and to a width of 5/8 inch (16 mm),  $\pm 1/8$  inch (3 mm). The crack shall be sawed with equipment specially designed to follow random cracks. Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent raveling or spalling. The joint shall be sealed with sealant in accordance with P-605 or as directed by the DEN PM.

**ii. Original joint.** If the original joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures.

Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

**(2) Full depth cracks and original joint cracked.** If there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced.

**d. Removal and replacement of full slabs.** Make a full depth cut perpendicular to the slab surface along all edges of the slab with a concrete saw cutting any dowels or tie-bars. Remove damaged slab protecting adjacent pavement from damage. Damage to adjacent slabs may result in removal of additional slabs as directed by the DEN PM at the Contractor's expense.

The underlying material shall be repaired, re-compacted and shaped to grade.

Dowels of the size and spacing specified for other joints in similar pavement on the project shall be installed along all four (4) edges of the new slab in accordance with paragraph 501-4.10d.

Placement of concrete shall be as specified for original construction. The joints around the new slab shall be prepared and sealed as specified for original construction.

**e. Spalls along joints.** Spalls along joints are for new or existing pavements.

**(1)** Spalls less than one inch wide and less than the depth of the joint sealant reservoir, shall be filled with joint sealant material.

**(2)** Spalls larger than one inch and/or deeper than the joint reservoir, but less than ½ the slab depth, and less than 25% of the length of the adjacent joint shall be repaired as follows:

i. Make a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inches (50 mm). Saw cuts shall be straight lines forming rectangular areas surrounding the spalled area.

ii. Remove unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete between the saw cut and the joint or crack with a light chipping hammer.

iii. Clean cavity with high-pressure water jets supplemented with compressed air as needed to remove all loose material.

iv. Apply a prime coat of epoxy resin, Type III, Grade I, to the dry, cleaned surface of all sides and bottom of the cavity, except any joint face.

v. Fill the cavity with low slump concrete or mortar or with epoxy resin concrete or mortar.

vi. An insert or other bond-breaking medium shall be used to prevent bond at all joint faces.

vii. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints.

**(3)** Spalls deeper than 1/2 of the slab depth or spalls longer than 25% of the adjacent joint require replacement of the entire slab.

**f. Diamond grinding of Concrete surfaces.** Diamond grinding shall be completed prior to pavement grooving. Diamond grinding of the hardened concrete should not be performed until the concrete is at least 14 days old and has achieved full minimum strength. Equipment that

causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified.

Diamond grinding shall be performed with a machine specifically designed for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with sufficient number of flush cut blades that create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The Contractor shall determine the number and type of blades based on the hardness of the aggregate. Contractor shall demonstrate to the DEN PM that the grinding equipment will produce satisfactory results prior to making corrections to surfaces.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. All grinding shall be at the expense of the Contractor.

### **CONTRACTOR QUALITY CONTROL (CQC)**

**501-5.1 Quality control program.** The Contractor shall develop a Quality Control Program in accordance with Item C-100. No partial payment will be made for materials that are subject to specific quality control requirements without an approved quality control program.

**501-5.2 Contractor Quality Control (CQC).** The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The DEN PM shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The DEN PM will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

**501-5.3 Contractor QC testing.** The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to this specification and as set forth in the CQCP. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content. A QC Testing Plan shall be developed and approved by the DEN PM as part of the CQCP.

The DEN PM may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the DEN PM, and if it can be demonstrated in the laboratory, in the presence of the DEN PM, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

#### **a. Fine aggregate.**

**(1) Gradation.** A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

**(2) Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

**(3) Deleterious substances.** Fine aggregate as delivered to the mixer shall be tested for deleterious substances in fine aggregate for concrete as specified in paragraph 501-2.1b, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

**b. Coarse Aggregate.**

**(1) Gradation.** A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

**(2) Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

**(3) Deleterious substances.** Coarse aggregate as delivered to the mixer shall be tested for deleterious substances in coarse aggregate for concrete as specified in paragraph 501-2.1c, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

**c. Slump.** One test shall be made for each subplot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

**d. Air content.** One test shall be made for each subplot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

**e. Unit weight and Yield.** One test shall be made for each subplot. Unit weight and yield tests shall be in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

**f. Temperatures.** Temperatures shall be checked at least four times per lot at the job site in accordance with ASTM C1064.

**g. Smoothness for Contractor Quality Control.**

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the DEN PM. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the

two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, or FHWA profile program ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

**(1) Transverse measurements.** Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the DEN PM. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

**(2) Longitudinal measurements.** Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously placed material the first measurement shall start with one half length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 501-4.19f or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 501-6.6.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

**h. Grade.** Grade will be evaluated prior to and after placement of the concrete surface.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 0.04 feet vertically and 0.1 feet laterally. The documentation will be provided by the Contractor to the DEN PM by the end of the following working day.

Areas with humps or depression that exceed grade or smoothness and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. If these areas cannot be corrected with grinding then the slabs that are retaining water must be removed and replaced in accordance with paragraph 501-4.19d. Grinding shall be in accordance with paragraph 501-4.19f. All corrections will be at the Contractors expense.

**501-5.4 Control charts.** The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content. The Contractor shall also maintain a control chart plotting the coarseness factor/workability factor from the combined gradations in accordance with paragraph 501-2.1d.

Control charts shall be posted in a location satisfactory to the DEN PM and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the DEN PM may halt production or acceptance of the material.

**a. Fine and coarse aggregate gradation.** The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Superimposed on the control charts shall be the action and suspension limits. Gradation tests shall be performed by the Contractor per ASTM C136. The Contractor shall take at least two samples per lot to check the final gradation. Sampling shall be per ASTM D75 from the flowing aggregate stream or conveyor belt.

**b. Slump and air content.** The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

**c. Combined gradation.** The Contractor shall maintain a control chart plotting the coarseness factor and workability factor on a chart in accordance with paragraph 501-2.1d.

#### Control Chart Limits<sup>1</sup>

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Gradation <sup>2</sup>	*3	*3
Coarseness Factor (CF)	±3.5	±5
Workability Factor (WF)	±2	±3
Slump	+0.5 to -1 inch (+13 to -25 mm)	+1 to -1.5 inch (+25 to -38 mm)
Air Content	±1.5%	±2.0%

<sup>1</sup> Control charts shall developed and maintained for each control parameter indicated.

<sup>2</sup> Control charts shall be developed and maintained for each sieve size.

<sup>3</sup> Action and suspension limits shall be determined by the Contractor.

**501-5.5 Corrective action at Suspension Limit.** The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of control. The CQCP shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

- a.** Fine and coarse aggregate gradation. When two consecutive averages of five tests are outside of the suspension limits, immediate steps, including a halt to production, shall be taken to correct the grading.

b. Coarseness and Workability factor. When the CF or WF reaches the applicable suspension limits, the Contractor, immediate steps, including a halt to production, shall be taken to correct the CF and WF.

c. Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher shall be adjusted.

d. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

d. Air content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

## **MATERIAL ACCEPTANCE**

**501-6.1 Quality Assurance (QA) Acceptance sampling and testing.** All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the DEN PM representatives. DEN QA will provide the facilities for the curing of beams for acceptance testing. The Contractor shall bear the cost of coring and filling operations, per paragraph 501-6.5b(1).

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

**501-6.2 Quality Assurance (QA) testing laboratory.** Quality assurance testing organizations performing these acceptance tests will be accredited in accordance with ASTM C1077. The quality assurance laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods will be submitted to the DEN PM prior to start of construction.

**501-6.3 Lot size.** Concrete will be accepted for strength and thickness on a lot basis. A lot will consist of a day's production not to exceed **4,000** square yards. Each lot will be divided into approximately equal sublots with individual sublots between 400 to 600 cubic yards. Where three sublots are produced, they will constitute a lot. Where one or two sublots are produced, they will be incorporated into the previous or next lot. Where more than one plant is simultaneously producing concrete for the job, the lot sizes will apply separately for each plant.

**501-6.4 Partial lots.** When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot or for overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they will constitute a lot. Where one or two sublots have been produced, they will be incorporated into the next lot or the previous lot and the total number of sublots will be used in the acceptance criteria calculation, that is,  $n=5$  or  $n=6$ .

**501-6.5 Acceptance Sampling and Testing.**

**a. Strength.**

**(1) Sampling.** One sample will be taken for each subplot from the concrete delivered to the job site. Sampling locations will be determined by the DEN PM in accordance with random sampling procedures contained in ASTM D3665. The concrete will be sampled in accordance with ASTM C172.

**(2) Test Specimens.** The DEN PM will be responsible for the casting, initial curing, transportation, and curing of specimens in accordance with ASTM C31. Three (3) specimens will be made from each sample and slump, air content, unit weight, and temperature tests will be conducted for each set of strength specimens. Within 24 to 48 hours, the samples will be transported from the field to the laboratory while in the molds. Samples will be cured in saturated lime water.

The strength of each specimen will be determined in accordance with ASTM C78. The strength for each subplot will be computed by averaging the results of the two test specimens representing that subplot.

**(3) Acceptance.** Acceptance of pavement for strength will be determined by the DEN PM in accordance with paragraph 501-6.6b(1). All individual strength tests within a lot will be checked for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and the remaining test values will be used to determine acceptance in accordance with paragraph 501-6.5b.

**b. Pavement thickness.**

**(1) Sampling.** One core will be taken by the Contractor for each subplot in the presence of the DEN PM. Sampling locations will be determined by the DEN PM in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, will be excluded from sample locations.

Cores shall be a minimum 4 inch (100 mm) in diameter neatly cut with a core drill. The Contractor will furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes will be filled by the Contractor with a non-shrink grout approved by the DEN PM within one day after sampling.

**(2) Testing.** The thickness of the cores will be determined by the DEN PM by the average caliper measurement in accordance with ASTM C174. Each core shall be photographed and the photograph included with the test report.

**(3) Acceptance.** Acceptance of pavement for thickness will be determined by the DEN PM in accordance with paragraph 501-6.6.

**501-6.6 Acceptance criteria.**

**a. General.** Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-6.5b:

- (1) Strength
- (2) Thickness
- (3) Grade
- (4) Profilograph smoothness. Not used
- (5) Adjustments for repairs

Acceptance for strength, thickness, and grade, will be based on the criteria contained in accordance with paragraph 501-6.6b(1), 501-6.6b(2), and 501-6.6b(3), respectively.

Production quality must achieve 90 PWL or higher to receive full pavement.

Strength and thickness will be evaluated for acceptance on a lot basis using the method of estimating PWL. Production quality must achieve 90 PWL or higher to receive full pavement. The PWL will be determined in accordance with procedures specified in Item C-110.

The lower specification tolerance limit (L) for strength and thickness will be:

#### Lower Specification Tolerance Limit (L)

<b>Strength</b>	0.93 × strength specified in paragraph 501-3.3
<b>Thickness</b>	Lot Plan Thickness in inches, - 0.50 in

#### b. Acceptance criteria.

**(1) Strength.** If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 501-8.1.

**(2) Thickness.** If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 501-8.1.

**(3) Grade.** The final finished surface of the pavement of the completed project will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically and 0.1 feet laterally. The documentation, stamped and signed by a licensed surveyor shall be in accordance with paragraph 501-5.3h. Payment for sublots that do not meet grade for over 25% of the subplot shall be reduced by 5% and not be more than 95%.

**(4) Profilograph roughness for QA Acceptance.** Not used.

**(5) Adjustments for repair.** Sublots with spall repairs, crack repairs, or partial panel replacement, will be limited to no more than 95% payment.

**(6) Adjustment for grinding.** For sublots with grinding over 25% of a subplot, payment will be reduced 5%.

### METHOD OF MEASUREMENT

**501-7.1** Concrete pavement shall be measured by the number of square yards of plain and reinforced pavement as specified in-place, completed and accepted. All dowels, reinforcement and additional concrete for thickened edges shall be considered incidental to the concrete pavement; no separate measurement or payment will be made for these items.

**501-7.2** Bond Breaker Fabric shall be measured by the number of square yards of materials placed and accepted by the DEN PM as complying with the plans and specifications excluding seam overlaps and edge anchoring.

### BASIS OF PAYMENT

**501-8.1 Payment.** Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 501-6.6. Acceptance Criteria shall be based on results of strength and thickness tests. Payment for acceptable lots of concrete pavement shall be adjusted in accordance with paragraph 501-8.1a for strength and thickness; 501-8.1b for repairs; 501-8.1c for grinding; and 501-8.1d for smoothness, subject to the limitation that:

The total project payment for concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of square yards of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings.

**a. Basis of adjusted payment.** The pay factor for each individual lot shall be calculated in accordance with the Price Adjustment Schedule table below. A pay factor shall be calculated for both strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both strength and thickness are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both strength and thickness are less than 100%.

#### Price Adjustment Schedule<sup>1</sup>

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject <sup>2</sup>

<sup>1</sup> Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% shall be subject to the total project payment limitation specified in paragraph 501-8.1.

<sup>2</sup> The lot shall be removed and replaced unless, after receipt of FAA concurrence, the Owner and Contractor agree in writing that the lot will remain; the lot paid at 50% of the contract unit price; and the total project payment limitation reduced by the amount withheld for that lot.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 501-8.1. Payment in excess of 100% for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100%; except for rejected lots which remain in place and/or sublots with adjustments for repairs.

**b. Adjusted payment for repairs.** The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots which contain repairs in accordance with paragraph 501-4.19 on more than 20% of the slabs within the sublot. Payment factors greater than 100 percent for the strength and thickness cannot be used to offset adjustments for repairs.

**c. Adjusted payment for grinding.** The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots with grinding over 25% of a subplot.

**d. Profilograph Roughness.** Not used.

- Item P-501-8.1** Portland Cement Concrete Pavement – 17” Non-Reinforced per square yard
- Item P-501-8.2** Portland Cement Concrete Pavement – 17” Reinforced per square yard
- Item P-501-8.3** Portland Cement Concrete Pavement – 9” Non-Reinforced per square yard
- Item P-501-8.4** Portland Cement Concrete Pavement – 9” Reinforced per square yard
- Item P-501-8.5** In-Pavement Light Blockout – per each
- Item P-501-8.6** Bond Breaker Fabric – per square yard

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

- ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
- ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- ASTM A704 Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
- ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars
- ASTM A884 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
- ASTM A934 Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
- ASTM A996 Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
- ASTM A1035 Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement
- ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- ASTM A1078 Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-501 CEMENT CONCRETE PAVEMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-501 CEMENT CONCRETE PAVEMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064	Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-501 CEMENT CONCRETE PAVEMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface
American Concrete Institute (ACI)	
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
Advisory Circulars (AC)	
AC 150/5320-6	Airport Pavement Design and Evaluation
Federal Highway Administration (FHWA)	
HIPERPAV 3, version 3.2	
Portland Concrete Association (PCA)	
PCA	Design and Control of Concrete Mixtures, 16 <sup>th</sup> Edition
U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD)	
CRD C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)
United States Air Force Engineering Technical Letter (ETL)	
ETL 97-5	Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

END ITEM P-501

## Item P-603 Emulsified Asphalt Tack Coat

### DESCRIPTION

**603-1.1** This item shall consist of preparing and treating an asphalt or concrete surface with asphalt material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

### MATERIALS

**603-2.1 Asphalt materials.** The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the DEN Project Manager (DEN PM) before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

### CONSTRUCTION METHODS

**603-3.1 Weather limitations.** The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the DEN PM.

**603-3.2 Equipment.** The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the DEN PM.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

**603-3.3 Application of emulsified asphalt material.** The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the DEN PM prior to application.

#### Emulsified Asphalt

Surface Type	Residual Rate, gal/SY (L/square meter)	Emulsion Application Bar Rate, gal/SY (L/square meter)
New asphalt	0.02-0.05 (0.09-0.23)	0.03-0.07 (0.13-0.32)
Existing asphalt	0.04-0.07 (0.18-0.32)	0.06-0.11 (0.27-0.50)
Milled Surface	0.04-0.08 (0.18-0.36)	.06-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the DEN PM. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed. When the tack coat has been disturbed by the Contractor, tack coat shall be reapplied at the Contractor's expense.

**603-3.4 Freight and waybills** The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the DEN PM certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

#### METHOD OF MEASUREMENT

**603-4.1** The emulsified asphalt material for tack coat shall be measured by the gallon. Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas

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where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

### BASIS OF PAYMENT

**603.5-1** Payment shall be made at the contract unit price per gallon of emulsified asphalt material. This price shall be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-603-5.1      Emulsified Asphalt Tack Coat - per gallon

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

**END ITEM P-603**

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## ITEM P-604A PREFORMED EXPANSION JOINT COMPRESSION SEALS

### DESCRIPTION

**604A-1.1** This item shall consist of a moisture tight sealing system for structural sealing of expansion joints in concrete pavement. The seal shall consist of an impermeable closed-cell, closed link, ethylene vinyl acetate, low-density polyethylene copolymer, nitrogen blown resilient, non-extrudable foam material with a Ultraviolet (UV) stabilizer added.

### MATERIALS

**604A-2.1 GENERAL.** The material shall be meet the following physical requirements in Table 1. The material must be jet fuel resistant, glycol compatible, and include a UV stabilizer.

**Table 1. Physical Requirements**

Test	Test Method	Requirements
Compression Set	ASTM D3575 Suffix B	10% - 2 Hr Recovery 9% - 24 Hr Recovery
Elongation at break	ASTM D3575 Suffix T	185% - 280%
Tensile Strength	ASTM D3575 Suffix T	92 - 140 psi
Tear Resistance	ASTM D624	10-20 lbs/in
Density	ASTM D3575 Suffix W	2.7 -3.4 lbs/ft <sup>3</sup>
Water Absorption	ASTM D3575 Suffix L	0.02 lbs/ft <sup>2</sup>
Weather/Deterioration	AASHTO T42	No Deterioration

**604A-2.2 ADHESIVE.** Adhesive used for the preformed foam compression seal shall be as recommended by the manufacturer.

**604A-2.3 DELIVERY AND STORAGE.** Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided at the job site to protect materials from weather and to maintain them at temperatures as recommended by the manufacturer.

**604A-2.4 SUBMITTALS.** Certified copies of test results shall be provided in accordance with Section 013300 Submittal Procedures and 013325 Shop and Working Drawings, Product Data and Samples.

**a. Construction Equipment List.** List of proposed equipment to be used in the performance of construction work, including descriptive data, shall be provided in accordance with Section 013300 and Section 013325.

**b. Manufacturer's Instructions.** Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of the recommendations shall be furnished in accordance with Section 013300 and Section 013325. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be a cause for rejection of the material.

**c. Test Reports/Samples.** The Contractor shall submit certified copies of the test reports and samples of the materials for approval in accordance with Section 013300 and Section 013325. Printed directions from the manufacturer on recommended installation criteria shall be furnished with the test reports, plus the manufacturer's certification that the selected seal is recommend for the installation on this project. No material will be used until it has been approved by the DEN Project Manager.

### **EQUIPMENT**

**604A-3.1** Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

**a. Joint Cleaning Equipment:**

**(1) Concrete Saw.** A self-propelled power saw with water cooled diamond or abrasive saw blades shall be provided for cutting joints to the depths and widths specified and for removing filler (existing old joint seal) or other material embedded in the joints or adhered to the joint faces.

**(2) Sandblasting Equipment.** Sandblasting shall not be permitted.

**(3) Water blasting Equipment.** Water blasting equipment shall include a trailer mounted water tank, pumps, high pressure hose, and a wand with safety release cutoff controls, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary water resupply equipment shall be sufficient capacity to permit continuous operations. The pumps, hoses, wand, and nozzle shall be of sufficient capacity to permit the cleaning of both walls of the joint and the pavement surface for a width of at least 1/2 inch on either side of the joint. The pump shall be capable of supplying a pressure of at least 3,000 psi. A pressure gauge mounted at the pump shall show at all times the pressure in pounds per square inch at which the equipment is operating.

### **CONSTRUCTION METHODS**

**604A-4.1 GENERAL.** Installation of foam joint sealant shall comply with Manufacturer's instructions and recommendations for foam joint sealant installation complete with a compatible epoxy adhesive for adhesion to all surfaces.

Prior to installing foam joint sealant, make certain that surfaces to which adhesive will adhere are clean and free of dust, dirt and other residues that would inhibit a proper bond.

The Contractor shall make arrangements for the Manufacturer's representative to meet with the Contractor and the DEN Project Manager prior to the start of sealing operations to ensure the installation procedures are in accordance with the Manufacturer's direction. A representative of the joint sealant manufacturer shall visit the job-site a sufficient number of times during the sealing operations and after the sealing is completed to certify that the joint sealant was installed in accordance with the manufacturer's recommended methods and procedures

**604A-4.2 PREPARATION OF JOINTS.** Immediately before installation of the preformed joint seal, the joints shall be thoroughly cleaned full depth to remove all laitance, filler, old existing sealant, foreign material and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Any irregularity in the joint face, which would prevent uniform contact between the joint seal and the joint face shall be corrected prior to the installation of the joint seal. All joint faces shall be vertical.

**a. Sawing.** Joints shall be sawed to clean and to open them to the full specified width and depth. Immediately following the sawing operation, the joint faces and opening shall be thoroughly cleaned using a water jet to remove all saw cuttings or debris remaining on the faces or in the joint opening. Compression seal shall be installed within 3 calendar days of the time the individual joint cavity is sawed. Depth of sawing the cavity shall be between  $\frac{3}{4}$  and 1 inch deeper than the uncompressed depth of the seal, or otherwise recommended by the manufacturer. The saw cut for the joint seal cavity shall at all locations be centered over the joint line. The nominal width of the sawed joint seal cavity shall be as follows; the actual width shall be within a tolerance of plus or minus 1/16 inch or as noted in the details.

**b. Sandblast Cleaning.** Sandblasting shall not be permitted.

**c. Waterblast Cleaning.** The concrete joint faces and pavement surfaces extending at least 1/2 inch from the joint edges shall be water blasted clean. A multiple pass technique shall be used until the surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the adhesive to the concrete. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water. When waterblast cleaning is used, slurry residue must be removed to provide a relatively dust free concrete surface.

**d. Rate of Progress.** The stages of joint preparation which includes water blasting of the joint faces and air pressure cleaning of the joints shall be limited to only the linear footage of joint that can be sealed during the same workday.

**604A-4.3 TIME OF INSTALLATION.** Joints shall be sealed within 3 calendar days of sawing the joint seal cavity and immediately following concrete cure and the final cleaning of the joint walls. Open joints ready for sealing that cannot be sealed under the conditions specified herein shall be provided with an approved temporary seal to prevent infiltration of foreign material. When rain interrupts the sealing operations, the joints shall be washed, air pressure cleaned and allowed to dry prior to installing the lubricant/adhesive and preformed seal.

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**604A-4.4 CLEAN UP.** Prior to Substantial Completion, all unused materials shall be removed from the site, any adhesive on the pavement surface shall be removed, and the pavement shall be left in clean condition.

**604A-4.5 WARRANTY.** The Manufacturer shall provide a warranty on the materials furnished for a minimum of 5 years from the date of acceptance by the DEN Project Manager. The Contractor shall provide a warranty on the installation for a minimum of 5 years from the date of acceptance by the DEN Project Manager.

**QUALITY CONTROL**

**604-5.1 PROCEDURES.** Quality control provisions shall be provided during the joint cleaning process to prevent or correct improper equipment and cleaning techniques that damages the concrete in any manner. Cleaned joints shall be approved by the DEN Project Manager prior to installation of the adhesive and preformed joint seal.

**604-5.2 PRODUCT.** The joint sealing system (preformed seal) shall be inspected for proper rate of cure and bonding to the concrete, cuts, twists, nicks, and other deficiencies. Seals exhibiting any defects, at any time prior to final acceptance of the project, shall be removed from the joint, wasted, and replaced in a satisfactory manner.

**METHOD OF MEASUREMENT**

**604-6.1** There shall be no direct measurement or payment for Preformed Expansion Joint Compression Seals associated with new pavement construction. The work under this item shall be considered incidental to the project.

**BASIS OF PAYMENT**

**604-7.1** Preformed Expansion Joint Compression Seals associated with new pavement construction shall be considered incidental to the project. No payment shall be made for Preformed Expansion Joint Compression Seals.

**TESTING REQUIREMENTS**

AASHTO T42	Standard Specification for Preformed Expansion Joint Filler for Concrete Construction
ASTM D 6211	Test Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 3575 SUFFIX B	Flexible Cellular Materials Made from Olefin Polymers
ASTM D 3575 SUFFIX L	Flexible Cellular Materials Made from Olefin Polymers
ASTM D 3575 SUFFIX T	Flexible Cellular Materials Made from Olefin Polymers
ASTM D 3575 SUFFIX W	Flexible Cellular Materials Made from Olefin Polymers

**END OF ITEM P-604A**

## Item P-605 Joint Sealants for Pavements

### DESCRIPTION

**605-1.1** This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints in pavement; joints between different types of pavements; and cracks in existing pavement.

### MATERIALS

**605-2.1 Joint sealants.** Joint sealant materials shall meet the requirements of ASTM D5893 for concrete joints or ASTM D6690-Type II for joints between concrete and asphalt.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

**605-2.2 Backer rod.** The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant in accordance with ASTM D5249. The backer-rod material shall be  $25\% \pm 5\%$  larger in diameter than the nominal width of the joint.

**605-2.3 Bond breaking tapes.** Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material shall have a melting point at least  $5^{\circ}\text{F}$  ( $3^{\circ}\text{C}$ ) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately  $1/8$  inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

### CONSTRUCTION METHODS

**605-3.1 Time of application.** Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be  $50^{\circ}\text{F}$  ( $10^{\circ}\text{C}$ ) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

**605-3.2 Equipment.** Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 14 days prior to use on the project.

**a. Concrete saw.** Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified.

**b. Sandblasting equipment.** Sandblasting is not allowed.

**c. Hand tools.** Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.

**d. Cold-applied, single-component sealing equipment.** The equipment for installing ASTM D5893 single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

**605-3.3 Preparation of joints.** Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. The Contractor shall demonstrate, in the presence of the DEN PM, that the method cleans the joint and does not damage the joint.

**a. Sawing.** All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

**b. Sealing.** Immediately before sealing, the joints shall be thoroughly cleaned of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant and other foreign material from the sides and upper edges of the joint space to be sealed. Cleaning shall be accomplished by sandblasting or concrete saw as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm) from it. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.

**c. Backer Rod.** When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a backer rod in accordance with paragraph 605-2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.

**d. Bond-breaking tape.** Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-separating tape breaker in accordance with paragraph 605-2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

**605-3.4 Installation of sealants.** Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the DEN PM before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch  $\pm$ 1/16 inch below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be

permitted over newly sealed pavement until authorized by the DEN PM. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

**605-3.5 Inspection.** The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

**605-3.6 Clean-up.** Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

**605-3.7 FIELD TEST.** Before sealing the joints, the Contractor shall demonstrate that the equipment and procedures for preparing, mixing, and placing the sealant will produce a satisfactory joint seal. The demonstration shall include the preparation of at least two small batches and the application of the resulting material in five joints of at least 25 feet in length each. A representative of the joint sealant manufacturer shall be present at the demonstration to ensure that the installation procedures are in accordance with the manufacturer's recommended installation instructions.

a. Testing For Cold Applied Silicone Sealants. When checking for adhesions of silicone, a pull test may be performed on the job site 21 days after the sealant has been placed.

1. Make a knife cut horizontally across and through the silicone from one side of the joint to the other.
2. Make a vertical cut approximately 2-3 inches long on each side of the joint starting at the horizontal cut, keeping the cuts the same length on each side.
3. Hold the piece of silicone firmly and slowly pull at a 90° degree angle stretching the silicone not more than 10" per minute as if trying to pull the adhered silicone out of the joint.
4. If adhesion is proper, the silicone will not pull out of the joint, but will eventually tear cohesively across the joint at the base of the knife cut.

b. If the silicone releases from the joint, adhesion has been affected. Several possible causes are:

1. Moisture in the joint during sealant application
2. Dirty or dusty joint sidewalls
3. Improper application (overfilling, etc.)
4. Spalling of the joint walls. (pieces of the concrete will be adhered to the silicone)

c. Repair of Sealant In Areas of Adhesion Test. The silicone sealant may be replaced by simply applying additional new silicone (normally using a tube of like silicone) in the same manner as it was originally placed, providing good adhesion was achieved. Proper preparation of the area should be performed prior to reapplying the silicone assuring the original silicone and the newly applied silicone are in good contact with each other.

**605-3.8 WARRANTY.** The manufacturer shall provide a warranty on the materials furnished for a minimum of 1 year from the date of acceptance by the DEN Project Manager. The Contractor shall provide a warranty on the installation for a minimum of 1 year from the date of acceptance by the DEN Project Manager.

**METHOD OF MEASUREMENT AND BASIS OF PAYMENT**

**605-4.1** No separate measurement or payment will be made for sawing or joint sealing on new pavements. The cost for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item shall be included in the Contractor's price for pavement.

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASTM International (ASTM)

ASTM D789	Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)
ASTM D5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D5893	Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt

## Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
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**END ITEM P-605**

## Item P-606

### Adhesive Compounds, Two-Component for Sealing Wire and Lights in Pavement

#### DESCRIPTION

**606-1.1** This specification covers two types of material; a liquid suitable for sealing electrical wire in saw cuts in pavement and for sealing light fixtures or bases in pavement, and a paste suitable for embedding light fixtures in the pavement. Both types of material are two-component filled formulas with the characteristics specified in paragraph 606-2.4. Materials supplied for use with asphalt and/or concrete pavements must be formulated so they are compatible with the asphalt and/or concrete.

#### MATERIALS

**606-2.1 Curing.** When pre-warmed to 77°F (25°C), mixed, and placed in accordance with manufacturer's directions, the materials shall cure at temperatures of 45°F (7°C) or above without the application of external heat.

**606-2.2 Storage.** The adhesive components shall not be stored at temperatures over 86°F (30°C), unless otherwise specified by the manufacturer.

**606-2.3 Caution.** Installation and use shall be in accordance with the manufacturer's recommended procedures. Avoid prolonged or repeated contact with skin. In case of contact, wash with soap and flush with water. If taken internally, call doctor. Keep away from heat or flame. Avoid vapor. Use in well-ventilated areas. Keep in cool place. Keep away from children.

**606-2.4 Characteristics.** When mixed and cured in accordance with the manufacturer's directions, the materials shall have the following properties shown in Table 1.

**Table 1. Property Requirements**

Physical or Electrical Property	Minimum	Maximum	ASTM Method
Tensile			
Portland cement concrete	1,000 psi (70 kg/sq cm)		D 638
Asphalt concrete	500 psi (35 kg/sq cm)		
Elongation			
Portland cement concrete		See note <sup>1</sup>	D 638
Asphalt concrete	50%		D 638
Coef. of cub. exp. cu. cm/cu. cm/°C	0.00090	0.00120	D 1168
Coef. of lin. exp. cm/cm/°C	0.000030	0.000040	D 1168
Dielectric strength, short time test	350 volts/mil.		D 149
Arc resistance	125 sec		
Pull-off			
Adhesion to steel	1,000 psi (70 kg/sq cm)		
Adhesion to Portland cement concrete	200 psi (14 kg/sq cm)		
Adhesion to asphalt concrete	No test available.		
Adhesion to aluminum	250 psi		

<sup>1</sup> 20% or more (without filler) for formulations to be supplied for areas subject to freezing.

## SAMPLING, INSPECTION, AND TEST PROCEDURES

**606-3.1 Tensile properties.** Tests for tensile strength and elongation shall be conducted in accordance with ASTM D638.

**606-3.2 Expansion.** Tests for coefficients of linear and cubical expansion shall be conducted in accordance with, Method B, except that mercury shall be used instead of glycerine. The test specimen shall be mixed in the proportions specified by the manufacturer, and cured in a glass tub approximately 2 inch (50 mm) long by 3/8 inch (9 mm) in diameter. The interior of the tube shall be precoated with a silicone mold release agent. The hardened sample shall be removed from the tube and aged at room temperature for one (1) week before conducting the test. The test temperature range shall be from 35°F (2°C) to 140°F (60°C).

**606-3.3 Test for dielectric strength.** Test for dielectric strength shall be conducted in accordance with ASTM D149 for sealing compounds to be furnished for sealing electrical wires in pavement.

**606-3.4 Test for arc resistance.** Test for arc resistance shall be conducted for sealing compounds to be furnished for sealing electrical wires in pavement.

**606-3.5 Test for adhesion to steel.** The ends of two smooth, clean, steel specimens of convenient size (1 inch by 1 inch by 6 inch) (25 mm by 25 mm by 150 mm) would be satisfactory when bonded together with adhesive mixture and allowed to cure at room temperature for a period of time to meet formulation requirements and then tested to failure on a Riehle (or similar) tensile tester. The thickness of adhesive to be tested shall be 1/4 inch (6 mm).

**606-3.6 Adhesion to Portland cement concrete**

**a. Concrete test block preparation.** The aggregate grading shall be as shown in Table 2.

The coarse aggregate shall consist of crushed rock having a minimum of 75% of the particles with at least one fractured face and having a water absorption of not more than 1.5%. The fine aggregate shall consist of crushed sand manufactured from the same parent rock as the coarse aggregate. The concrete shall have a water-cement ratio of 5.5 gallons (21 liters) of water per bag of cement, a cement factor of 6,  $\pm 0.5$ , bags of cement per cubic yard (0.76 cubic meter) of concrete, and a slump of 2-1/2 inch (60 mm),  $\pm 1/2$  inch (60 mm  $\pm 12$  mm). The ratio of fine aggregate to total aggregate shall be approximately 40% by solid volume. The air content shall be 5.0%,  $\pm 0.5\%$ , and it shall be obtained by the addition to the batch of an air-entraining admixture such as Vinsol® resin. The mold shall be of metal and shall be provided with a metal base plate.

Means shall be provided for securing the base plate to the mold. The assembled mold and base plate shall be watertight and shall be oiled with mineral oil before use. The inside measurement of the mold shall be such that several one inch (25 mm) by 2-inch (75 mm) by 3-inch (25 mm by 50 mm by 75 mm) test blocks can be cut from the specimen with a concrete saw having a diamond blade. The concrete shall be prepared and cured in accordance with ASTM C192.

**Table 2. Aggregate for Bond Test Blocks**

Type	Sieve Size	Percent Passing
<b>Coarse Aggregate</b>	3/4 inch (19.0 mm)	97 to 100
	1/2 inch (12.5 mm)	63 to 69
	3/8 inch (9.5 mm)	30 to 36
	No. 4 (4.75 mm)	0 to 3
<b>Fine Aggregate</b>	No. 4 (4.75 mm)	100
	No. 8 (2.36 mm)	82 to 88
	No. 16 (1.18 mm)	60 to 70
	No. 30 (600 $\mu$ m)	40 to 50
	No. 50 (300 $\mu$ m)	16 to 26
	No. 100 (150 $\mu$ m)	5 to 9

**b. Bond test.** Prior to use, oven-dry the test blocks to constant weight at a temperature of 220°F to 230°F (104°C to 110°C), cool to room temperature, 73.4°F  $\pm 3$ °F (23°C  $\pm 1.6$ °C), in a desiccator, and clean the surface of the blocks of film or powder by vigorous brushing with a stiff-bristled fiber brush. Two test blocks shall be bonded together on the one inch by 3 inch (25 mm by 75 mm) sawed face with the adhesive mixture and allowed to cure at room temperature for a period of time to meet formulation requirements and then tested to failure in a Riehle (or similar) tensile tester. The thickness of the adhesive to be tested shall be 1/4 inch (6 mm).

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TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-606 ADHESIVE COMPOUNDS, TWO-COMPONENT  
FOR SEALING WIRE AND LIGHTS IN PAVEMENT

DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02

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**606-3.7 Compatibility with asphalt mix.** Test for compatibility with asphalt in accordance with ASTM D5329.

**606-3.8 Adhesive compounds - Contractor's responsibility.** The Contractor shall furnish the vendor's certified test reports for each batch of material delivered to the project. The report shall certify that the material meets specification requirements and is suitable for use with concrete or asphalt concrete pavements. The report shall be provided to and accepted by the DEN Project Manager( DEN PM) before use of the material. In addition, the Contractor shall obtain a statement from the supplier or manufacturer that guarantees the material for one year. The supplier or manufacturer shall furnish evidence that the material has performed satisfactorily on other projects.

**606-3.9 Application.** Adhesive shall be applied on a dry, clean surface, free of grease, dust, and other loose particles. The method of mixing and application shall be in strict accordance with the manufacturer's recommendations. When used with Item P-605, such as light can installation, Item P-605 shall not be applied until the Item P-606 has fully cured.

#### METHOD OF MEASUREMENT AND BASIS OF PAYMENT

**606-4.1** No separate measurement or payment will be made for adhesive compounds sealing wire lights in pavements. The cost for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item shall be included in the Contractor's price for lights in pavements.

#### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D5329	Standard Test Methods for Sealants and Fillers, Hot-applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements

**END OF ITEM P-606**

## Item P-610 Concrete for Miscellaneous Structures

### DESCRIPTION

**610-1.1** This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

### MATERIALS

**610-2.1 General.** Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the DEN Project Manager (DEN PM) before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

**a. Reactivity.** Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the DEN PM. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20% the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation; or aggregates that meet P-501 reactivity test requirements may be utilized.

**610-2.2 Coarse aggregate.** The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

### Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1 1/2 inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
¾ inch (19 mm)	67
½ inch (12.5 mm)	7

**610-2.2.1 Coarse Aggregate susceptibility to durability (D) cracking.** Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test requirements but must meet all other quality tests specified in Item P-501.

**610-2.3 Fine aggregate.** The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

**610-2.4 Cement.** Cement shall conform to the requirements of ASTM C150 Type V. Type I/II LA cement may be substituted for Type V cement, subject to DEN PM approval, should the Type I/II LA cement meet Type V requirements for sulfate resistance, deleterious activity, and total alkali content.

#### 610-2.5 Cementitious materials.

**a. Fly ash.** Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the DEN PM.

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

**610-2.6 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**610-2.7 Admixtures.** The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the DEN PM may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the DEN PM from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

**a. Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

**b. Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

**c. Other chemical admixtures.** The use of set retarding, and set-accelerating admixtures shall be approved by the DEN PM. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

**610-2.8 Premolded joint material.** Premolded joint material for expansion joints shall meet the requirements of ASTM D1751.

**610-2.9 Joint filler.** The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

**610-2.10 Steel reinforcement.** Reinforcing shall consist of Bar Mats conforming to the requirements of ASTM A184.

**610-2.11 Materials for curing concrete.** Curing materials shall conform to ASTM C309.

## CONSTRUCTION METHODS

**610-3.1 General.** The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the DEN PM.

**610-3.2 Concrete Mixture.** The concrete shall develop a compressive strength in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39.

- a. 4,500 psi for utility structure installation or adjustment.
- b. 4,000 psi for concrete encased lighting ducts and light cans.
- c. 1,200 psi at 7 days for the repair of cement treated base course.

The concrete shall contain not less than 615 – 660 pounds of cementitious material (cement plus fly ash) per cubic yard for 4,500 psi in 28 days, nor less than 470 pounds of cementitious material per cubic yard for 4,000 psi in 28 days, and as needed for 1,200 psi in 7 days. The concrete shall contain 6% of entrained air, +/-1.5%, as determined by ASTM C231 and shall have a slump of not more than 6 inches as determined by ASTM C143.

**610-3.3 Mixing.** Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the DEN PMs approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted unless Contractor obtains approval of DEN PM to follow ASTM C94, paragraph 12.7 for concrete delivered in truck mixer or truck agitator.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

**610-3.4 Forms.** Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the DEN PM. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

**610-3.5 Placing reinforcement.** All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

**610-3.6 Embedded items.** Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

**610-3.7 Concrete Consistency.** The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

**610-3.8 Placing concrete.** All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the DEN PM. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its

final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

**610-3.9 Vibration.** Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

**610-3.10 Joints.** Joints shall be constructed as indicated on the plans.

**610-3.11 Finishing.** All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

**610-3.12 Curing and protection.** All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

**610-3.13 Cold weather placing.** When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

**610-3.14 Hot weather placing.** When concrete is placed in hot weather greater than 85°F (30°C), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

## **QUALITY ASSURANCE (QA)**

**610-4.1 Quality Assurance sampling and testing.** Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The DEN PM will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

The first load of concrete, per mix, delivered each day will be sampled and tested.

Concrete placed for structures will be sampled and tested for each additional 50 cubic yards per day with a minimum one test per structure. When a single load of concrete is used for more than one structure, that load will be sampled and tested once.

Concrete placed for structures will be sampled and tested for each additional 50 cubic yards per day.

Lean concrete will be sampled and tested for each additional 50 cubic yards per day.

Concrete strengths for acceptance shall be the average of at least two 6 by 12 inch or at least three 4 by 8 inch cylinders tested at 28 days.

**610-4.2 Defective work.** Any defective work that cannot be satisfactorily repaired as determined by the DEN PM, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

### **METHOD OF MEASUREMENT**

**610-5.1** In general, and unless listed in the proposal as a separate payment item, structural concrete will not be measured for payment, but shall be incidental to those proposed items constructed of concrete.

**610-5.2** Cement-Treated Base Course Repair shall be measured per square yard including existing cement treated base milling and structural concrete installation.

### **BASIS OF PAYMENT**

**610-6.1** Structural concrete shall be considered incidental to the project. No payment shall be made for structural concrete, unless listed in the proposal as a separate payment item.

**610-6.2** Payment for Cement-Treated Base Course Repair shall be made at the contract price by the number of square yards. This price shall be full compensation for furnishing all materials including reinforcement and embedded items and for all preparation, delivery, installation, and curing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

**610-6.3** Payment shall be made at the contract price by the number of linear feet for existing DIW force main concrete encasement. This price shall be full compensation for furnishing all materials including reinforcement and embedded items and for all preparation, delivery, installation, and curing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-610-6.1	Cement-Treated Base Course Repair – per square yard
Item P-610-6.2	Existing DIW Force Main Concrete Encasement – per linear foot

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-610 CONCRETE FOR  
MISCELLANEOUS STRUCTURES**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-610 CONCRETE FOR  
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ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
American Concrete Institute (ACI)	
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to External Curing of Concrete
ACI 309R	Guide for Consolidation of Concrete

**END OF ITEM P-610**

## Item P-620 Runway and Taxiway Marking

### DESCRIPTION

**620-1.1** This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the DEN Project Manager (DEN PM). The terms “paint” and “marking material” as well as “painting” and “application of markings” are interchangeable throughout this specification.

### MATERIALS

**620-2.1 Materials acceptance.** The Contractor shall furnish manufacturer’s certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer’s surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the DEN PM prior to the initial application of markings. The reports can be used for material acceptance or the DEN PM may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the DEN PM upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the DEN PM.

**620-2.2 Marking materials.**

**Table 1. Marking Materials**

Paint <sup>1</sup>				Glass Beads <sup>2</sup>	
Type	Color	Fed Std. 595 Number	Application Rate Maximum	Type	Application Rate Minimum
Waterborne Type I or II	Yellow	33538	115 ft <sup>2</sup> /gal	Type I, Gradation A	7 lb/gal
Waterborne Type I or II	Black	37038	115 ft <sup>2</sup> /gal	Not Used	Not Used
Methacrylate	Yellow	33538	45 ft <sup>2</sup> /gal	Type I, Gradation A	15 lb/gal
Methacrylate	Black	37038	45 ft <sup>2</sup> /gal	Not Used	Not Used

<sup>1</sup> See paragraph 620-2.2a

<sup>2</sup> See paragraph 620-2.2b

**a. Paint.** Paint shall be waterborne or methacrylate in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595.

**Waterborne.** Paint shall meet the requirements of Federal Specification TT-P-1952F, Type I or Type II. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis.

**Methacrylate.** Paint shall be a two component, minimum 99% solids-type system conforming to the following:

**(1) Pigments.** Component A. Percent by weight.

**(a) White:**

- Titanium Dioxide, ASTM D476, type II shall be 10% minimum.
- Methacrylate resin shall be 18% minimum.

**(b) Yellow and Colors:**

- Titanium Dioxide, ASTM D476, type II shall be 1% minimum.  
Organic yellow, other colors, and tinting as required to meet color standard.
- Methacrylate resin shall be 18% minimum.

**(2) Prohibited materials.** The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

**(3) Daylight directional reflectance:**

**(a) White:** The daylight directional reflectance of the white paint shall not be less than 80% (relative to magnesium oxide), when tested in accordance with ASTM E2302.

**(b) Yellow:** The daylight directional reflectance of the yellow paint shall not be less than 55% (relative to magnesium oxide), when tested in accordance with ASTM E2302. The x and y values shall be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x	.462	x	.470	x	.479	x	.501
y	.438	y	.455	y	.428	y	.452

**(4) Accelerated weathering.**

**(a) Sample preparation.** Apply the paint at a wet film thickness of 0.013-inch (0.33 mm) to four 3 × 6-inch (8 × 15 cm) aluminum panels prepared as described in ASTM E2302. Air dry the sample 48 hours under standard conditions.

**(b) Testing conditions.** Test in accordance with ASTM G154 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating four (4) hour UV exposure at 140°F (60°C), and four (4) hours condensate exposure at 104°F (40°C).

**(c) Evaluation.** Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 3 above. Evaluate for conformance with the color requirements.

**(5) Volatile organic content.** Determine the volatile organic content in accordance with 40 CFR Part 60 Appendix A, Method 24.

**(6) Dry opacity.** Use ASTM E2302. The wet film thickness shall be 0.015 inch (0.38 mm). The minimum opacity for white and colors shall be 0.92.

**(7) Abrasion resistance.** Subject the panels prepared in paragraph 620-2.2c(4) to the abrasion test in accordance with ASTM D968, Method A, except that the inside diameter of the metal guide tube shall be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters (17.5 lb (7.94 kg)) of unused sand shall be used for each test panel. The test shall be run on two test panels. Both baked and weathered paint films shall require not less than 150 liters (525 lbs (239 kg)) of sand for the removal of the paint films.

**(8) Hardness, shore.** Hardness shall be at least 60 when tested in accordance with ASTM D2240.

**(9) Additional requirements for methacrylate splatter profiled pavement marking.** Pavement markings of this type shall comply with all above requirements for methacrylate paint, except as noted below:

(a) The thickness of the marking will be irregular ranging from 0.000 to 0.250 inches (0.00 to 6.4 mm), applied in a splatter pattern which comprises a minimum of 80% of the visible line (when traveling at 5 mph the line appears to be solid.).

(b) The hardness shall be 48 Shore D minimum.

**b. Reflective media.** Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type I, Gradation A.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A.

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

## CONSTRUCTION METHODS

**620-3.1 Weather limitations.** Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

**620-3.2 Equipment.** Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

**620-3.3 Preparation of surfaces.** Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminants that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface

preparation shall be approved in advance by the DEN PM. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

**a. Preparation of new pavement surfaces.** The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the DEN PM to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

**b. Preparation of pavement to remove existing markings.** Existing pavement markings shall be removed by water blasting or by other methods approved by the DEN PM minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.

**c. Preparation of pavement markings prior to remarking.** Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the DEN PM. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the DEN PM prior to the initial application of markings.

**620-3.4 Layout of markings.** The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

**620-3.5 Application.** A period of 30 days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the DEN PM.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

#### Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing

glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

**620-3.6 Application--preformed thermoplastic airport pavement markings.** Preformed thermoplastic pavement markings not used.

**620-3.7 Control strip.** Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the DEN PM. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

**620-3.8 Retro-reflectance.** Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

#### Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m <sup>2</sup> /lux		
	White	Yellow	Red
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than <sup>1</sup>	100	75	10

<sup>1</sup> Prior to remarking determine if removal of contaminants on markings will restore retro-reflectance

**620-3.9 Protection and cleanup.** After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the DEN PM. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

#### METHOD OF MEASUREMENT

**620-4.1** The quantity of markings for shall be paid for shall be measured by the number of square feet of painting.

**620-4.2** The quantity of temporary markings to be paid for shall be the number of square feet of painting performed in accordance with the specifications and accepted by the DEN PM.

Temporary marking includes surface preparation, application and complete removal of the temporary marking.

**620-4.3** The quantity of stop signs, VSR delineators, and bollards to be paid for shall be per each in accordance with the drawings.

### BASIS OF PAYMENT

**620-5.1** This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the DEN PM in accordance with these specifications.

**620-5.2** Payment for markings shall be made at the contract price for the number of square feet of painting.

**620-5.3** Payment for temporary markings shall be made at the contract price for the number of square feet of painting. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

**620-5.4** Payment for stop signs, VSR delineators, and bollards shall be made at the contract unit price for the number of stop signs, VSR delineators, and bollards installed. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-620-5.1	Pavement Marking Removal – per square foot
Item P-620-5.2	Pavement Marking (Waterborne) – per square foot
Item P-620-5.3	Non-Reflective Pavement Marking (Waterborne) - per square foot
Item P-620-5.4	Pavement Marking (Methacrylate) – per square foot
Item P-620-5.5	Non-Reflective Pavement Marking (Methacrylate) – per square foot
Item P-620-5.6	Temporary Pavement Marking – per square foot
Item P-620-5.7	Stop Sign – per each
Item P-620-5.8	VSR Delineator – per each
Item P-620-5.9	Install Bollard – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-620 RUNWAY AND TAXIWAY MARKING**
**DENVER INTERNATIONAL AIRPORT**  
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ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2302	Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

## Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24  
Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

## Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D	Beads (Glass Spheres) Retro-Reflective
FED SPEC TT-P-1952F	Paint, Traffic and Airfield Marking, Waterborne
FED STD 595	Colors used in Government Procurement

## Advisory Circulars (AC)

AC 150/5340-1	Standards for Airport Markings
AC 150/5320-12	Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

**END OF ITEM P-620**

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**TECHNICAL SPECIFICATIONS  
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## Item D-701 Pipe for Storm Drains and Culverts

### DESCRIPTION

**701-1.1** This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

### MATERIALS

**701-2.1** Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

**701-2.2 Pipe.** The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C1840	Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe

**701-2.3 Concrete.** Concrete for pipe cradles shall be in accordance with P-610.

**701-2.4 Rubber gaskets.** Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the "RE" closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

**701-2.5 Joint mortar.** Pipe joint mortar shall consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**701-2.6 Joint fillers.** Poured filler for joints shall conform to the requirements of ASTM D6690.

**701-2.7 Plastic gaskets.** Plastic gaskets shall conform to the requirements of ASTM C990.

**701-2.8. Controlled low-strength material (CLSM).** Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used, all joints shall have gaskets.

**701-2.9 Precast box culverts.** Not used.

**701-2.10 Precast concrete pipe.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association Cast Plant Certification program.

**701-2.11 Solvent Cement.** Solvent Cement shall conform to the requirements of Section 221316-2.2(l).

**701-2.12 Backwater Valve.** Denver water vault drain line backwater vales shall conform to the requirements of Division 22.

## CONSTRUCTION METHODS

**701-3.1 Excavation.** The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactorily jointing of the pipe and thorough compaction of the bedding material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade should be filled with granular material to form a uniform foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The DEN PM shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

In the event of ground water invasion of the trench, the contractor shall be responsible for all dewatering work as subsidiary to the contract pay items. There will be no additional payment for pumping, dewatering wells, over excavation, etc. due to ground water.

**701-3.2 Bedding.** The pipe bedding shall conform to the requirements of CDOT Standard Specifications for Class 4 aggregate base course (CDOT Table 703-2).

**a. Rigid pipe.** The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

**b. Flexible pipe.** For flexible pipe, the bedding material shall be in accordance with Item P-153.

**c. Other pipe materials.** For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

**701-3.3 Laying pipe.** The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

**701-3.4 Joining pipe.** Joints shall be made with (1) cement mortar, (2) cement grout, (3) rubber gaskets, (4) plastic gaskets, (5) coupling bands, or (6) solvent-cementing (plastic, non-pressure piping).

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

**a. Concrete pipe.** Concrete pipe may be either bell and spigot or tongue and groove. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Concrete pipe joints shall be sealed with rubber gaskets meeting ASTM C443 when leak resistant joints are required.

**b. Metal pipe.** Metal pipe shall be firmly joined by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

**c. PVC, Polyethylene, or Polypropylene pipe.** Joints for PVC, Polyethylene, or Polypropylene pipe shall conform to the requirements of ASTM D3212 when leak resistant joints are required. Joints for PVC and Polyethylene pipe shall conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M252 or ASTM M294. Fittings for polypropylene pipe shall conform to ASTM F2881, ASTM F2736, or ASTM F2764. Solvent-cemented plastic pipe joint materials and installation methods shall be in conformance with Section 221316.

**d. Fiberglass pipe.** Not used.

**701-3.5 Embedment and Overfill.** Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

#### **701-3.5-1 Embedment Material Requirements**

**a. Concrete Pipe.** Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM

C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

**b. Plastic Pipe.** Embedment material shall meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material shall be free of organic material, stones larger than 1.5 inches in the greatest dimension, or frozen lumps. Embedment material shall extend to 12 inches above the top of the pipe.

**c. Metal Pipe.** Embedment material shall be granular as specified in the contract document and specifications, and shall be free of organic material, rock fragments larger than 1.5 inches in the greatest dimension and frozen lumps. As a minimum, backfill materials shall meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material shall extend to 12 inches above the top of the pipe.

#### **701-3.5-2 Placement of Embedment Material**

The embedment material shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level, whichever is greater. Thoroughly compact the embedment material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under Item P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.

It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

#### **701-3.6 Overfill**

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be placed and compacted in layers as required to achieve compaction of at least 95 percent standard proctor per ASTM D698. The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

#### **701-3.7 Inspection Requirements**

An initial post installation inspection shall be performed by the DEN PM no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM D-701 PIPE FOR STORM DRAINS AND CULVERTS**

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For pipe sizes larger than 48 inches, a walk-through visual inspection shall be performed.

Incorporate specific inspection requirements for the various types of pipes beneath the general inspection requirements.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm.

Flexible pipes shall be inspected for rips, tears, joint separations, soil migration, cracks, localized buckling, settlement, alignment, and deflection. Determine whether the allowable deflection has been exceeded by use of a laser profiler for internal pipe diameters of 48 inches or less, or direct measurement for internal pipe diameters greater than 48 inches. Laser profile equipment shall utilize low barrel distortion video equipment. Deflection of installed pipe shall not exceed the limits provided in the table below, as a percentage of the average inside diameter of the pipe.

Maximum Allowable Pipe Deflection

Type of Pipe	Maximum Allowable Deflection (%)
Corrugated Metal Pipe	5

If deflection readings in excess of the allowable deflection are obtained, remove the pipe with excessive deflection and replace with new pipe. Isolated areas may exceed allowable by 2.5% with concurrence of DEN PM. Repair or replace any pipe with cracks exhibiting displacement across the crack, bulges, creases, tears, spalls, or delaminations. The report for flexible pipe shall include as a minimum, the deflection results and final post installation inspection report. The inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design line and grade, and inspector's notes.

### **701-3.8 Quality Assurance/ Quality Control**

#### **a. Qualifications.**

1. Pipe Manufacturer: The Contractor shall submit verifiable information of satisfactory manufacturing experience for the past 5 years with design and fabrication of reinforced concrete pipe of similar size and design.
2. Installer: Contractor shall submit verifiable information of satisfactory experience in the installation of reinforced concrete storm sewer pipe of similar size and extent, with a minimum of 5 years experience.

#### **b. Testing.** All pipe shall be certified by the pipe manufacturer.

1. Yard testing of Pipe for Certification. Testing shall be performed in accordance with ASTM C 443 on a minimum of two (2) lengths of pipe and one (1) complete joint for every 500 linear feet of pipe, or less.
2. Testing of Installed Pipe. ASTM C 1103 shall be followed to field test pipe joints. The test procedure shall be used for joint acceptance of all installed concrete pipe. All field joints shall be tested and certified before backfilling operations are allowed to begin.

Acceptance testing may involve hazardous materials, operations and equipment. These specifications do not address the safety problems associated with the testing procedures. It is the responsibility of the Contractor to establish appropriate safety and health practices.

3. Repair of Joints that Test as Unacceptable. In the event of a reinforced concrete pipe joint failing the in-place pressure test, identified above, the Contractor shall repair the joint by injecting a chemical grout into the joint circumference.

The chemical grout shall be a non-flammable liquid which, when activated by water, forms a flexible closed-cell polyurethane foam. The chemical grout shall be resistant to petroleum products. The chemical grout shall be DE NEEF® Flex LV PRe or DE NEEF® Flex SLV PRe, as applicable, manufactured by GCP Applied Technologies Inc., Cambridge, MA 02140, or approved equal. Chemical grout shall be prepared, mixed, injected and cured in accordance with the manufacturer's recommendations.

The equipment used to inject the chemical grout shall be of construction similar to that of the pressure testing equipment. Chemical grout shall be injected into the joint at a in accordance with the manufacturer's recommendations to insure the grout penetrates through the leak to the outside of the joint.

After injecting the chemical grout, the injection valves shall be shut off to prevent backflow of the grout. The chemical grout shall have adequate time to cure prior to removal of the injection equipment. The joint shall be retested after repair in accordance with the pressure testing procedure described in these specifications.

4. Gasket Material Test. Gaskets may be exposed to petroleum products. Gasket material shall be certified to have complied with ASTM C 443 and petroleum resistant characteristics of ASTM C 361.

5. Backfill Tests. Refer to Section P-152 for test and test frequency.

**c. Submittals.** The Contractor shall make the following submittals to the Project Manager for review and approval, or testing, as the case may be:

1. Pipe Design and Detail Drawings. If the Contractor elects to use an alternate pipe, then the Contractor shall prepare or cause to be prepared, complete design calculations, plans, cross-sections, shop details for all pipe and accessories, and trench shoring/bracing system design for all trenches 20 feet in depth or greater. All final design calculations, plans, and shop drawings shall be sealed by a currently registered Professional DEN Project Manager in the State of Colorado whose disciplines is in the field of civil or structural engineering.

2. Qualifications. Refer to 701-3.6a.

3. Pipe Certification. The Contractor shall submit the results and certifications for tested pipe made in the pipe manufacturer's shop (refer to Part 701-3.6a.(1)). The Contractor shall further provide certification of each spool piece of pipe as it is delivered to the job site.

This certification shall accompany the pipe bill of lading.

**d. Pipe Field Joint Test Certification.** The Contractor shall maintain records of all pipe joint tests. A copy of these test records shall be turned over to the Project Manager with a letter certifying that all joints under construction have been tested in accordance with the specifications for joint seal and integrity.

**e. Pipe Manufacturer’s QA/QC Program.** The manufacturer of reinforced concrete pipe shall have in place at all times an active Quality Assurance and Quality Control Program. A written copy of this program shall be on file in the manufacturer’s shop at all times. The Contractor shall submit copies of the QA/QC Program to the Project Manager for review and approval prior to the start of manufacture of pipe.

**f. Mill Test Certificates.** The pipe manufacturer to retain on file a copy of mill certification reports for the reinforcing steel and cement used in the manufacture of the concrete pipe. An appropriate number of copies of said certifications shall be submitted to the Project Manager.

**g. Pipe Gasket Certification Test.** The Contractor shall selectively test the “O” ring synthetic rubber gasket material at an approved independent testing laboratory. Certified results shall be submitted to the Project Manager for review and approval.

**h. Inspection.** All pipe shall be inspected at the yard prior to shipment, at the point of receipt and when placed in the trench prior to backfilling. The Project Manager shall inspect all pipe to be used for damage prior to installation. Pipe shall be inspected for damage and compliance to the manufacturer’s specifications and Contract Drawings. Units that are damaged shall be evaluated for the extent of damage. If, in the opinion of the Project Manager, damage is extensive enough to reduce the strength, durability, integrity, or ability to properly function with other parts of an installation (i.e. joint damage), the unit shall be rejected and the Contractor shall immediately remove the unit from the Project site. The Contractor may repair minor damage, if so authorized by the Project Manager, but at no cost to the City.

#### METHOD OF MEASUREMENT

**701-4.1** The length of pipe shall be measured in linear feet (m) of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. Each class, type and size of pipe shall be measured separately. Pipe encasement and all fittings shall be included in the footage as typical pipe sections in the pipe being measured.

#### BASIS OF PAYMENT

**701-5.1** These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, bedding, backfill, encasement, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

**701-5.2** Payment will be made at the contract unit price per linear foot for the following pipe installed complete in place, and accepted by the DEN PM:

Item D-701-5.1	18-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.2	24-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.3	30-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.4	36-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.5	24-Inch PVC (Schedule 80)
Item D-701-5.6	42-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.7	48-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.8	54-Inch Reinforced Concrete Pipe (Class V)

Item D-701-5.9 60-Inch Reinforced Concrete Pipe (Class V)

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

#### ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar

**TECHNICAL SPECIFICATIONS  
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ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3282	Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
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ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
National Fire Protection Association (NFPA)	
NFPA 415	Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways

**END ITEM D-701**

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## Item D-702 Slotted Drains and Trench Drains

### DESCRIPTION

**702-1.1** This item shall consist of the construction of steel slotted drains, cast iron slotted vane drains or trench drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans. Typical details shall be shown on the plans.

### MATERIALS

**702-2.1 General.** All slotted drains shall meet the requirements shown on the plans and specified below. All slotted drains shall meet specified hydraulic design requirements and shall support the loadings specified.

**702-2.2 Trench Drain Channels.** Trench drain channels shall be pre-formed modular units with interlocking joints. Each channel segment shall be at least 6 ¼ inches wide for section in VSR areas and at least 12 inches wide inner diameter. Trench slope and depth is as specified on the drawings. Deviations from plan slope, width, and depth shall not be allowed as it directly impacts hydraulic capacity, storage capacity, and velocity. Channels shall have a radius or trapezoidal bottom as shown on plans and will allow for a monolithic concrete pour eliminating cold joints and water stop materials from being used in the trench invert. Forms and removal of forms shall not interfere or compromise the structural integrity of the load transfer assembly between the frame and encapsulation concrete. Forms, mounting brackets and liners shall be fully removed, without exception, to allow for 100% inspection of concrete consolidation. Inspection of consolidation below frames shall be 100%, partial inspection points will not be allowed. Formwork assembly must be prevented from floating during concrete placement without penetrating the sub grade. A means to assure constant frame spacing and grate seat dimension shall be provided.

Trench drain channels shall be supplied with epoxy lining. Epoxy lining type shall be submitted to the DEN Project Manager (DEN PM) for approval, prior to procuring trench drain systems for installation.

- a. **Steel slotted drain.** Not used.
- b. **Cast iron slotted vane drain.** Not used.

**702-2.3 Frames and Grates.** Frames for channel units shall be either cast-iron, ductile-iron, or galvanized steel and shall have anchors designed to provide positive anchorage into the surrounding concrete. Frames shall have a minimum of two anchors attached to each side for each channel unit. Frames shall be capable of being mechanically fastened to the channel unit.

Grates shall be either cast iron or ductile iron and shall be rated for an aircraft wheel load of 200,000 pounds with a maximum tire pressure of 250 psi.

Grates shall have a minimum of four locking devices to securely fasten the grate to the frame or to the channel unit to prevent the grate from becoming loose under traffic conditions. The locking devices shall be designed to allow easy installation and removal of the grates from the

completed trench drain, not obstruct flow in the channel, and not require any modifications to the channel units or frames to install the devices.

- a. **Steel Slotted Drain** Not used.
- b. **Cast iron slotted vane drain.** Not used.

**702-2.4 Concrete.** Concrete used shall conform to the requirements of Item P-610.

**702-2.5 Steel Reinforcement.** Reinforcing used in the concrete slab surrounding the modular trench drain system shall consist of deformed steel bars conforming to the requirements of ASTM A184. The steel shall be epoxy coated (green bar).

**702-2.6 Pre-Molded Joint Filler.** Pre-molded joint filler for expansion joints around the trench drain shall conform to the requirements of P-604A Preformed Expansion Joint Compression Seals. The filler for contract joints shall conform to the requirements of P-605 Joint Sealants for Pavements.

**702-2.7 Joint Sealer.** The joint sealer for the concrete joints shall meet the requirements of item P-605 joint sealing filler.

**702-2.8 Outlet Pipe.** Pipe for trench drain outlets shall be Schedule 80 galvanized steel and shall meet the requirements for ASTM A53.

**702-2.9 Cover Material for Curing.** Curing materials shall conform to the requirements of Item P-610.

**702-2.10 Submittals.** The Contractor shall submit shop drawings for the modular trench system in accordance with Section 013300 Submittal and Procedures and Section 013325 Shop and Working Drawings, Product Data and Samples. Shop drawings shall include the manufacturer's name, material specifications, hydraulic data, copies of test data determining wheel load capacity, installation procedures, and the proposed layout of the system with all appropriate dimensions.

**702-2.11 Acceptable Manufacturers.** The following manufacturers are known to have acceptable modular trench drain systems.

<b>Installation Location</b>	<b>Product Name</b>	<b>Manufacturer</b>
Aircraft Areas	Z874 Perma-Trench	Zurn
	Polydrain	ABT Inc.
GSE Areas	Polydrain	ABT, Inc.

Modular trench drain systems shall be one as listed above or approved equal. Request for approval of equal or equivalent trench system shall be submitted at least 10 days prior to ordering materials. In addition to technical data, a full-scale section shall be provided for examination.

**702-2.12 Warranty.** The Manufacturer shall provide a warrant on the materials furnished for 5 years from the date of Substantial Completion. The Contractor shall provide a warrant on the installation for 5 years from the date of Substantial Completion.

## CONSTRUCTION METHODS

**702-3.1 Excavation.**

The Contractor shall excavate existing base or subgrade materials as required to install the trench drain system to the lines, grades or elevations shown on the Contract Drawings. The Contractor shall accomplish the required excavation in such a manner so as not to damage drainage structures or adjacent concrete pavement. After the excavation is completed for each section of trench drain, the DEN PM shall approve the depth of the excavation and the condition of the trench bottom before the Contractor places any reinforcing steel, channel units or concrete.

Excavation shall not be measured for direct payment. The cost of this work shall be included in the contract unit price for trench drains.

**702-3.2 Installation.** Modular trench drain channel units shall be installed in accordance with the details on the Contract Drawings and with the manufacturer's recommendations. Channel units and outlet pipes shall be securely fastened in place so that they will not be displaced or moved during the placing of the concrete. The use of soil, sand, stone or wood to support the bottom or sides of the channel units or outlet pipes will not be allowed.

The Contractor shall set the trench drain channels in such a manner so as to maintain proper horizontal and vertical alignment. Channels shall be set with the top of the grate 1/2 inch below the elevation of the adjacent finished concrete. Channels shall be properly secured to hold the set horizontal and vertical alignment and to prevent floatation prior to placing the surrounding concrete. Frames shall be secured to the channels and grates wrapped with a protective material and locked in place before placing the concrete. Grates may be replaced with a temporary cover that can be securely fastened to the channel and is suitable to prevent concrete from entering the channels.

**702-3.3 Placing Reinforcement.** All reinforcement shall be accurately placed, as shown on the Contract Drawings, and shall be firmly held in position during concreting. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs.

**702-3.4 Placing Concrete Backfill.** After the installation of the trench drain channels and the reinforcing steel has been approved in accordance with Item P-610, the Contractor shall place concrete backfill around the trench drain. The concrete shall be placed with an approved discharge device that will not allow segregation of the materials and will not allow the concrete to chute directly against the channel sides. The concrete placement shall alternate from side to side to prevent disturbing the set channel alignment and shall be continuous between expansion joints. Concrete shall be thoroughly consolidated against and along the faces of the adjacent concrete pavement and along the full length and on both sides of the trench drain by means of vibrators inserted in the concrete. Vibrators shall not be allowed to come in contact with the trench drain channels or the grade and shall not be allowed to operate longer than 3 seconds in anyone location. Necessary hand spreading of concrete shall be done with shovels, and not with rakes or vibrators.

The forms holding the trench drain assembly shall be backfilled with concrete that will easily flow under and around the reinforcement and grating material. The top of grates and castings shall be covered to prevent unwanted material from entering the drain during the backfilling and subsequent surfacing operations.

**702-3.5 Joints.** Expansion joints shall be installed as indicated on the Contract Drawings. The pre-molded filler shall be securely fastened into position with a metal cap provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has

been placed and struck off, the cap shall be carefully withdrawn leaving the space over the pre-molded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic.

Contraction joints shall be formed in the plastic concrete using a preformed insert material as indicated on the Contract Drawings. The installation and edge finish shall be according to the manufacturer's instructions. Contractor shall create contraction joints, concurrent with trench drain installation, while the concrete is still plastic. Green sawing the joints after the trench is placed is not proper means-and-methods for achieving the desired results. Use of a rigid polystyrene extrusion that creates a straight-line controlled crack (contraction joint) in the concrete is permitted, to eliminate random cracking in all variations and thicknesses of slabs where a control joint is required.

The trench drain section contains a reinforcing steel cage, with surface clearance to the steel of 3-inches minimum. Extrusion material shall be installed to a depth (2-inch minimum) which provides for 1-inch clearance overtop the steel for corrosion protection.

**702-3.6 Surface Finish.** Final strike off and finishing of the concrete surface shall be accomplished in accordance with Item P-501.

**702-3.7 Sealing Joints.** The joints in the trench drain concrete slab shall be sealed in accordance with Item P-605.

**702-3.8 Cleaning and Restoration of Site.** Grates or temporary covers shall be removed if grates were wrapped with protective material, this material shall be removed to permit final cleaning and inspection. Clean any deposited concrete on other debris from the trench drain channel. Install grates in the trench drain frame and lock the grates down with the locking device provided by the manufacturer.

**702-3.9 Acceptance Sampling and Testing.** Sampling and testing of concrete backfill shall be in accordance with Item P-610.

## **METHOD OF MEASUREMENT**

**702-4.1** The accepted quantity of trench drain shall be measured in linear feet as a complete unit, irrespective of trench drain depth, for completed and approved trench drain. It shall be measured along the center of the trench drain slab from the outside face of the abutting inlet structure to the end of the trench drain slab or to the outside face of the abutting inlet structure, whichever is applicable. No separate measurement will be made for trench base preparation and backfill materials, concrete, steel reinforcing, or trench drain outlet pipes, as these items shall be considered incidental to the pay item installation.

## **BASIS OF PAYMENT**

**702-5.1** Payment shall be made at the contract unit price per linear foot for complete, in-place, and approved trench drain. This price shall be full compensation for all materials, including trench drain channels, grates and frames, outlet pipes, reinforcing steel, and concrete backfill and installation of these materials and all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D-702-5.1      Install Trench Drain – per linear foot

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

### ASTM International (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A184	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types)
ASTM D1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

### American Association of State Highway and Transportation Officials (AASHTO)

AASHTO-AGC-ARTBA Task Force 13 Report A Guide to Standardized Highway Drainage Products

**END OF ITEM D-702**

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM D-702 SLOTTED DRAINS AND TRENCH DRAINS**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item D-705 Pipe Underdrains for Airports

### DESCRIPTION

**705-1.1** This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

### MATERIALS

**705-2.1 General.** Materials shall meet the requirements shown on the plans and specified below.

**705-2.2 Pipe.** The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
ASTM F758	Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

**705-2.3 Joint mortar.** Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206.

**705-2.4 Elastomeric seals.** Elastomeric seals shall conform to the requirements of ASTM F477.

**705-2.5 Porous backfill.** Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

**Table 1. Gradation of Porous Backfill**

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. *
1-1/2 inch (37.5 mm)	100*
1 inch (25.0 mm)	90 - 100*
3/8 inch (9.5 mm)	25 - 60*
No. 4 (4.75 mm)	5 - 40*
No. 8 (2.36 mm)	0 – 20 *

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

**705-2.6 Granular material.** Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

**705-2.7 Filter fabric.** The filter fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent.

**Table 2. Fabric Properties**

Fabric Property	Test Method	Test Requirement
Grab Tensile Strength, lbs	ASTM D4632	125 min
Grab Tensile Elongation %	ASTM D4632	50 min
Burst Strength, psi	ASTM D3787	125 min
Trapezoid Tear Strength, lbs	ASTM D4533	55 min
Puncture Strength, lbs	ASTM D4833	40 min
Abrasion, lbs	ASTM D4886	15 max loss
Equivalent Opening Size	ASTM D4751	70-100
Permittivity sec <sup>-1</sup>	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

**705-2.8 Controlled low-strength material (CLSM).** Controlled low-strength material shall conform to the requirements of Item P-153. All joints shall have elastomeric seals.

**705-2.9 Concrete.** Concrete shall conform to the requirements of Item P-610.

**705-2.10 Castings.** Metal frames and covers for cleanouts shall be gray iron castings conforming to the requirements of ASTM A48, Class 20.

## CONSTRUCTION METHODS

**705-3.1 Equipment.** All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the DEN PM before construction is permitted to start.

**705-3.2 Excavation.** The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly

compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The DEN PM shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the DEN PM. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the DEN PM and compacted to the density of the surrounding material.

The pipe bedding shall be constructed uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 inch when the bedding thickness is less than 6 inches, and 1-1/2 inch when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed, uncompacted material under the middle third of the pipe prior to placement of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

### **705-3.3 Laying and installing pipe.**

**a. Concrete pipe.** The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and re-laid by the Contractor at no additional expense. Making adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it shall be prohibited. If the installed pipe section is not to grade, the pipe section shall be completely removed, the grade corrected, and the pipe rejoined.”

**b. Metal pipe.** The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands that is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

**c. PVC, fiberglass, or polyethylene pipe.** PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321. Perforations shall meet the requirements of

AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Fiberglass per ASTM D3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

**d. All types of pipe.** The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the DEN PM.

Unless otherwise shown on the plans, a 4-inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

**e. Filter fabric.** The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with the AASHTO M288 Appendix, unless otherwise shown on the plans.

**705-3.4 Mortar.** The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

**705-3.5 Joints in concrete pipe.** When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches (75 mm) nor more than 6 inches (150 mm), unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2 (Table 1), as shown on the plans or as directed by the DEN PM.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the DEN PM.

### **705-3.6 Embedment and Backfill**

**a. Earth.** All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The embedment material shall be select material from excavation or borrow and shall be approved by the DEN PM. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the DEN PM. The material shall be moistened or dried, as required to aid compaction. Placement of the embedment material shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The embedment material shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches (200 mm). Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the DEN PM, until the trench is completely filled and brought to the planned elevation. Embedment and backfilling shall be done to avoid damaging top or side of the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

**b. Granular backfill.** When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the DEN PM, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

**c. Controlled low-strength material (CLSM).** Controlled low-strength material shall conform to the requirements of Item P-153.

**705-3.7 Flexible Pipe Ring Deflection.** The flexible pipe shall be inspected by the Contractor during and after installation to ensure that the internal diameter of the pipe barrel has not been

reduced by more than 5 percent. For guidance on properly sizing mandrels, refer to ASTM D3034 and ASTM F679 appendices.

**705-3.8 Connections.** When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

**705-3.9 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the DEN PM. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

### METHOD OF MEASUREMENT

**705-4.1** The length of pipe shall be the number of linear feet of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

**705-4.2** The quantity of filter fabric shall not be measured or paid for separately but will be considered incidental to the project. The work under this item shall be considered subsidiary to the other items of work.

**705-4.3** The quantity of underdrain cleanouts and connection to existing underdrain cleanouts shall be the number of in place, completed, and approved structures. All trenching, excavation, removal of excavated material, backfill, compaction, concrete, and pipe fittings shall be included in the number of underdrain cleanouts being measured.

### BASIS OF PAYMENT

**705-5.1** Payment will be made at the contract unit price per linear foot (meter) for pipe underdrains of the type, class, and size designated.

**705-5.2 Filter fabric.** Filter fabric shall be considered incidental to the project. No payment shall be made for filter fabric.

**705-5.3 Pipe underdrains, Complete.** Pipe underdrains, complete (including porous backfill and filter fabric) shall be made at the contract unit price per linear foot complete (including porous backfill and filter fabric).

**705-5.4 Install Underdrain Cleanout.** The accepted quantity of underdrain cleanouts and connections to existing cleanouts will be paid for at the contract unit price per each in place when completed.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D-705-5.1	6-Inch Perforated Underdrain Pipe – per linear foot
Item D-705-5.2	6-Inch Non-Perforated Underdrain Pipe – per linear foot
Item D-705-5.3	Underdrain Cleanout – per each

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Item D-705-5.4	Underdrain Connection to Inlet – per each
Item D-705-5.5	Connect to Existing Underdrain – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C206	Standard Specification for Finishing Hydrated Lime
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM D-705 PIPE FOR UNDERDRAINS FOR AIRPORTS**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

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American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M190	Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500- mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO	Standard Specifications for Highway Bridges

**END OF ITEM D-705**

## ITEM D-710 SOIL RIPRAP

### DESCRIPTION

**710-1.1** This item shall consist of furnishing and placing of soil riprap as shown on the plans and called for in these specifications. Where buried soil riprap is called out on the plans, six (6) inches of topsoil will be placed on top of the soil riprap. Placing of riprap will include all mixing and soil placement, bedding (if applicable), fabric (if applicable), and stones as indicated on the plans or as directed by the DEN Project Manager.

### MATERIALS

**710-2.1** **STONE.** All stone for rock riprap shall be sound, durable, and free from seams, cracks, and other defects and shall be as nearly rectangular as practicable. Rounded riprap (river rock) is not acceptable. The stone shall have a specific gravity of at least 2.5.

- a. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.
- b. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
- c. The bulk density for the riprap shall be 1.3 ton/cy or greater.
- d. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
- e. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
- f. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
- g. Rock shall be free of calcite intrusions.
- h. Gradation:
  1. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.

2. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.
3. Gradation of Type M Riprap shall be as shown in Table 1 below.

**Table 1.**

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension Inches	d <sub>50</sub> * inches
Type L	70-100	15	9
	50-70	12	
	35-50	9	
	2-10	3	
Type M	70-100	21	12
	50-70	18	
	35-50	12	
	2-10	4	
Type H	70-100	30	18
	50-70	24	
	35-50	18	
	2-10	6	

\*d<sub>50</sub> = Mean particle size

**710-2.2 SUBMITTALS.** Contractor shall submit certification that the product delivered to the project site will have values equal to or greater than those specified above.

Stone – Certification of Compliance detailing gradation and specific gravity.

### CONSTRUCTION METHODS

**710-3.1 EXCAVATION.** The slopes shall be finished to a reasonably smooth and compact surface within 2 inches (5 cm) of the lines, surfaces, and elevations shown on the plans.

### 710-3.2 SOIL RIPRAP.

- a. Adjacent stockpiles of riprap and soil shall be created, and mixing done at the stockpile location, not at the location where soil riprap is to be placed.

- b.** Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.
- c.** Place a first layer of smaller soil riprap of approximate d50 thickness. Then place the top layer with surface rocks that are largely d50 or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane with projections above or depressions under the finished design grade no more than ten percent (10%) of the rock layer thickness.
- d.** The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.
- e.** The soil shall be further wetted to encourage void filling with soil.
- f.** Excessively thick zones of soil prone to washing away shall not be created; no thickness greater than 6 inches.
- g.** For buried soil riprap, the top surface shall be covered with six (6) inches of topsoil such that no rock points are protruding.
- h.** The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

#### **METHOD OF MEASUREMENT**

**710-4.1** Soil Riprap shall be measured by the cubic yard, to the dimensions of the riprap as shown on the plans or as directed by the DEN Project Manager. Excavation and mixing are included in the contract unit price for Soil Riprap and no separate measurement of payment will be made for them.

#### **BASIS OF PAYMENT**

**710-5.1** The accepted quantity of Riprap will be paid for at the contract unit price per cubic yard. The price shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

- Item D-710-5.1      Type “L” Soil Riprap – Per Cubic Yard
- Item D-710-5.2      Type “H” Soil Riprap – Per Cubic Yard

#### **END OF ITEM D-710**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM D-710 SOIL RIPRAP**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

### DESCRIPTION

**751-1.1** This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the DEN PM.

### MATERIALS

**751-2.1 Brick.** Not used.

**751-2.2 Mortar.** Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**751-2.3 Concrete.** Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

**751-2.4 Precast concrete pipe manhole rings.** Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

**751-2.5 Corrugated metal.** Not used.

**751-2.6 Frames, covers, and grates.** The castings shall conform to one of the following requirements:

- a. ASTM A48, Class 35B: Gray iron castings
- b. ASTM A47: Malleable iron castings
- c. ASTM A27: Steel castings
- d. ASTM A283, Grade D: Structural steel for grates and frames
- e. ASTM A536, Grade 65-45-12: Ductile iron castings
- f. ASTM A897: Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Castings shall be coated per DEN Division 09 requirements.

**751-2.7 Steps.** Steps or ladders shall not be installed in any structure, including: vaults, manholes, handholes, storm structures, sanitary structures, jet-fuel structures, EFSO structures electrical structures, etc., unless directed otherwise by the DEN PM.

**751-2.8 Precast inlet structures.** Manufactured in accordance with and conforming to ASTM C913.

**751-2.9 Reinforcing Steel.** All reinforcing steel be manufactured in accordance with and conforming to ASTM A615, Grade 60.

**751-2.10 Epoxy Lining System.** 100 percent solids, plural component epoxy, capable of spray or trowel application. System capable of application to damp concrete in high relative humidity environment. Resistant to attack from hydrogen sulfide and sulfuric acids generated from microbiological sources. System shall meet requirements of ASTM C722 and ASTM D1763, and be 100 percent solids epoxy resin. A minimum finish thickness of 125 mils is required. Properties: Minimum requirements are as follows. If a specific manufacturer product is identified in the following sections, the minimum requirements are per the individual product.

- a. Bond Strength, ASTM C478: Concrete failure.
- b. Tensile Strength, ASTM C307: 2,500 psi, minimum.
- c. Flexural Strength, ASTM C580: 4,800 psi.
- d. Moisture Absorption, ASTM C413: 0.1 percent.
- e. Shrinkage, ASTM C631: 0.11 percent, maximum.

Manufacturers and Products:

Manufacturers	Products
1. Environmental Coatings, Inc.	Sewer-Shield 100 (Trowel) Sewer-Shield 101S (Spray) Sewer-Shield 101A Sewer-Shield 150
2. Sauereisen, Inc.	SewerGard 210X Epoxy
3. Warren Environmental, Inc.	S-301 Epoxy

## CONSTRUCTION METHODS

### 751-3.1 Unclassified excavation.

**a.** The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as staked by the DEN PM. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the DEN PM may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

**b.** Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut

to a firm surface either level, stepped, or serrated, as directed by the DEN PM. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After excavation is completed for each structure, the Contractor shall notify the DEN PM. No concrete or reinforcing steel shall be placed until the DEN PM has approved the depth of the excavation and the character of the foundation material.

#### **751-3.2 Brick structures. Not used.**

**751-3.3 Concrete structures.** Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. When claystone (undisturbed natural or fill) is encountered in the base of the excavation within paved areas as determined by the DEN Project Manager, the material shall be over-excavated to a depth of 3 feet below and 3 feet beyond the sides of the base of the structure. The over-excavation shall be replaced with Select Embankment material meeting the requirements for Item P-152. The Select Embankment material shall be placed in 8 inch thick loose lifts, moisture conditioned and compacted to the requirements of Item P-152.

The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the DEN PM before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

**751-3.4 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another DEN PM approved third party certification program.

When required by the DEN Project Manager, the precast manufacturer shall provide detailed structural analysis of the structure being provided that considers the live and dead loads exposed to the structure. The analysis shall be signed and sealed by an engineer registered in the state of installation normally performing structural engineering.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required.

Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

**751-3.5 Corrugated metal structures.** Not used.

**751-3.6 Inlet and outlet pipes.** Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

**751-3.7 Placement and treatment of castings, frames, and fittings.** All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the DEN PM, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the DEN PM. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

**751-3.8 Installation of steps.** Steps or ladders shall not be installed in any structure, including: vaults, manholes, handholes, storm structures, sanitary structures, jet-fuel structures, EFSO structures, electrical structures, etc., unless directed otherwise by the DEN PM.

**751-3.9 Epoxy Lining.**

**a.** Coverage: System shall be applied/cover all walls, underside of top slab, chimney, corbel, bench, and invert of the manhole. System shall be applied after manhole is completely constructed in its permanent location to prevent seams or gaps in the lining.

**b.** Surface Preparation: Perform surface preparation in presence of DEN Project Manager or designated representative, unless DEN Project Manager agrees Work may be performed in DEN Project Manager's or designated representative's absence. Clean and prepare surface of new concrete in accordance with recommendations of manufacturer.

**c.** Inflow and Infiltration: Do not apply coating if inflow or infiltration are present. New manholes should be constructed to prevent inflow and infiltration. If inflow or infiltration are present notify DEN Project Manager or designated representative.

**d.** Installation: DEN Project Manager or designated representative will inspect all cleaned and repaired manholes before application of lining system; provide 24 hour notification. Apply or install system in accordance with the manufacturer's recommendations. Upon completion of work, DEN Project Manager or designated representative will inspect all rehabilitated manholes and be present for testing. Manufacturer/manufacturer's representative shall inspect all rehabilitated manholes.

**751-3.10 Backfilling.**

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the DEN PM.

b. Backfill shall not be placed against any structure until approved by the DEN PM. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

**751-3.11 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the DEN PM. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

**751-3.12 Quality Assurance/ Quality Control.**

a. Qualifications. The Contractor shall meet the same qualifications for precast pipe structures as are identified in Item D-701 and shall impose all qualifications on its pipe manufacturer. Should the Contractor elect to cast-in-place junction structures, the Contractor shall be able to demonstrate experience with similar structures.

b. Tests. Tests for precast concrete pipe structures (including pipe joints) shall have imposed the same tests as for precast pipe in Item D-701. Refer to Item P-610 for cast-in-place concrete test requirements. All backfill material shall be tested for compaction in accordance with Items D-701 and P-152.

(1) Epoxy lining: Measure and record twice daily air, concrete substrate, and lining surface temperatures within structure during mixing, application, and curing of materials; verify compliance with manufacturer's temperature ranges. Measure and record twice daily relative humidity within structure during mixing, application, and curing of materials; verify compliance with manufacturer's requirements. Wet Film Thickness Gauge: During application, use wet film thickness gauge; meet ASTM D4414 to ensure monolithic coating and uniform thickness. Holiday Detection: In accordance with NACE SPO 188. After 24 hours minimum, spark test lining system to ensure pinhole-free lining. Mark defects and repaired per manufacturer's instructions. Voltage to be set at 100 volts per mil of epoxy thickness. After identification of pinholes, thin areas, and other imperfections, re-apply epoxy material and retest. Adhesion Test: Test 10 percent minimum of manholes for adhesion/bond of coating to substrate. DEN Project Manager or designated representative will select manholes to be tested. Conduct in accordance with ASTM D7234 as modified herein. Prepare coating and dollies to receive adhesive. Attach three 20 millimeter dollies minimum. Adhesive used to attach dollies to coating shall be rapid setting with tensile strength in excess of coating product and permitted to cure in accordance with manufacturer's recommendations. Deemed failure of if pull value is lower than required minimum shall be deemed a non-test and require retesting. Prior to performing pull test, score through applied coating into substrate by 30 mils by mechanical means without disturbing dolly or bond within test area. Two (2) of the three (3) adhesion pulls shall exceed

200 psi or concrete failure with more than 80 percent of subsurface adhered to coating. Should a structure fail to achieve two successful pulls as described above, perform additional testing at discretion of DEN Project Manager. Areas detected to have inadequate bond strength shall be evaluated by DEN Project Manager or designated representative. Further bond tests may be performed in area to determine extent of potentially deficient bonded area. Repair deficient areas.

c. Inspections. Inspection for precast concrete pipe structures shall follow inspection procedures identified in Item D-701 for precast pipe and those of Item P-152 for excavation. Inspection for cast-in-place concrete structures shall follow Item P-610.

d. Submittals.

1. Materials. Materials shall be submitted in accordance with Items P-610 and D-701.
2. Designs and Drawings. If the Contractor elects to use an alternative pipe, then the Contractor shall design or cause the pipe manufacturer to design all precast pipe structures to the specified criteria. The Contractor shall submit support calculations, installation drawings, and detail drawings for review and approval by the Project Manager prior to proceeding with fabrication of structures. Calculations, drawings, and details shall be sealed and signed by a Professional Engineer currently registered in the State of Colorado.

Should the Contractor elect to substitute and construct precast and/or cast-in-place concrete structures, the Contractor shall submit full designs and details, as above, sealed and signed by a Professional Engineer currently registered in the State of Colorado.

### **METHOD OF MEASUREMENT**

**751-4.1** Manholes, inlets, diversion structures, inspection holes, connections to and adjustment of structures shall be measured by the unit complete in place and accepted by the DEN PM.

### **BASIS OF PAYMENT**

**751-5.1** The accepted quantities of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item D-751-5.1	Type E Manhole (10' - 20' Depth) - per each
Item D-751-5.2	Type E Manhole (20' - 30' Depth) - per each
Item D-751-5.3	Type E Manhole (30' - 40' Depth) - per each
Item D-751-5.4	Type E Manhole (DIW Force Main) - per each
Item D-751-5.5	Type F Manhole (10' – 20' Depth) - per each
Item D-751-5.6	Type F Manhole (20' – 30' Depth) - per each

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM D-751 MANHOLES, CATCH BASINS, INLETS AND**  
**INSPECTION HOLES**


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Item D-751-5.7	Type F Manhole (30' – 40' Depth) - per each
Item D-751-5.8	Type G Manhole - per each
Item D-751-5.9	Type H Manhole (10' – 20' Depth) - per each
Item D-751-5.10	Type H Manhole (30' – 40' Depth) - per each
Item D-751-5.11	Type 1 Quad Inlet - per each
Item D-751-5.12	Type 2 Double Inlet - per each
Item D-751-5.13	Type 2 Triple Inlet - per each
Item D-751-5.14	Type 2 Quad Inlet - per each
Item D-751-5.15	Type I Diversion Structure, 2 Gates - per each
Item D-751-5.16	Type I Diversion Structure, 2 Gates, with Weir - per each
Item D-751-5.17	Type I Diversion Structure, with Weir - per each
Item D-751-5.18	Trench Drain Inlet (58" x 90")
Item D-751-5.19	Trench Drain Inlet (92" x 90")
Item D-751-5.20	Adjust Existing DIW Manhole - per each
Item D-751-5.21	Adjust Electrical Manhole - per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM D-751 MANHOLES, CATCH BASINS, INLETS AND  
INSPECTION HOLES**

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ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures.
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

END OF ITEM D-751

## Item D-752 Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures

### DESCRIPTION

**752-1.1** This item shall consist of plain and reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the DEN PM.

### MATERIALS

**752-2.1 Concrete.** Plain and reinforced concrete shall meet the requirements of Item P-610.

**752-2.2 Structural steel.** Structural steel for shall meet the requirements of ASTM A36 (Grade 60).

### CONSTRUCTION METHODS

#### **752-3.1 Unclassified excavation.**

**a.** Trenches and foundation pits for structures or structure footings shall be excavated to the lines and grades and elevations shown on the plans. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only; and the DEN PM may approve, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

**b.** Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the DEN PM. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing steel is placed.

**c.** The Contractor shall do all bracing, sheathing, or shoring necessary to perform and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for excavation.

**d.** All bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage the finished concrete. The cost of removal shall be included in the unit price bid for excavation.

**e.** After each excavation is completed, the Contractor shall notify the DEN PM. No concrete or reinforcing steel shall be placed until the DEN PM has approved the depth of the excavation and the character of the foundation material.

**752-3.2 Backfilling.**

a. After a structure has been completed, backfilling with approved material shall be accomplished by applying the fill in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required under item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the DEN PM.

b. No backfilling shall be placed against any structure until approved by the DEN PM. For concrete, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained 75% of its design strength to withstand any pressure created by the backfill or the placement methods.

c. Fill placed around concrete culverts shall be deposited on each side at the same time and to approximately the same elevation. All slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent wedge action against the structure.

d. Backfill will not be measured for direct payment. Performance of this work shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for the structures involved.

**752-3.3 Weep holes.** Weep holes shall be constructed as shown on the plans.

**752-3.4 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankment, shoulders, or as approved by the DEN PM. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

**752-3.5 Quality Assurance/ Quality Control.**

a. Inspection. Mandatory hold points are established for inspection by the Project Manager for all reinforcing steel, embedded items, and concrete placement for structures by Item P-610. Excavation shall be inspected when completed and after forms and reinforcing is installed in accordance with Item P-610. Final grading shall be inspected to assure smooth transition at and around drainage courses.

b. Testing. Refer to Item P-610 for concrete testing requirements and to Item P-152 for soils testing requirements.

c. Submittals.

(1) Reinforcing Steel Detail Drawings. All structure reinforcing steel shall be detailed and shop drawings provided in accordance with the requirements of Item P-610, including utility blockouts, expansion joints and construction joints.

(2) Waterstop product data in conformance with plans.

(3) Excavation and shoring drawings, if required..

**METHOD OF MEASUREMENT**

**752-4.1** Concrete headwalls (including wingwalls) and other miscellaneous drainage structures shall be measured by the unit.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM D-752 CONCRETE CULVERTS, HEADWALLS, AND**  
**MISCELLANEOUS DRAINAGE STRUCTURES**

**DENVER INTERNATIONAL AIRPORT**  
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**752-4.1** Unclassified excavation, concrete and reinforcing steel required for the installation for each structure will not be measured but shall be considered incidental to each structure bid item.

### **BASIS OF PAYMENT**

**752-5.1** The accepted quantities of concrete headwalls (including wingwalls) and other miscellaneous drainage structures will be paid for at the contract unit price per each in place when completed and accepted by the DEN PM.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and placing the materials, and for all labor, equipment, tools, and incidentals necessary to complete the structure.

Payment will be made under:

Item D-752-5.1	60-Inch SDG Headwall - per each
Item D-752-5.2	24-Inch RCP Flared End Section - per each
Item D-752-5.3	30-Inch RCP Flared End Section - per each

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

**END OF ITEM D-752**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM D-752 CONCRETE CULVERTS, HEADWALLS, AND  
MISCELLANEOUS DRAINAGE STRUCTURES**

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## Item T-901 Seeding

### DESCRIPTION

**901-1.1** This item shall consist of soil preparation, seeding and fertilizing the areas shown on the plans or as directed by the DEN PM in accordance with these specifications.

### MATERIALS

**901-2.1 Seed.** The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the DEN PM duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be applied as follows:

#### Non-Saline Upland Seed Mix For Shoulder

Scientific Name	Common Name	Variety	lbs PLS/acre*	%of mix**
<i>Bouteloua curtipendula</i>	Sideoats Grama	Vaughn	0.8	10
<i>Bouteloua gracilis</i>	Blue Grama	Bad River	0.05	2.5
<i>Bouteloua gracilis</i>	Blue Grama	Hachita	0.05	2.5
<i>Buchloe dactyloides</i>	Buffalograss	Cody	0.7	2.5
<i>Buchloe dactyloides</i>	Buffalograss	Native – VNS <sup>†</sup>	0.7	2.5
<i>Distichlis spicata</i> v. <i>stricta</i>	Inland Saltgrass	Native – VNS <sup>†</sup>	0.3	5
<i>Elymus lanceolatus</i> v. <i>lanceolatus</i>	Thickspike Wheatgrass	Critana	1.1	11
<i>Elymus lanceolatus</i> v. <i>psammophilus</i>	Streambank Wheatgrass	Sodar	1.0	10
<i>Elymus trachycaulus</i>	Slender Wheatgrass	Primar	0.5	5

**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM T-901 SEEDING**

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Nasella viridula	Green Needlegrass	LoDorm	0.8	5
Poa secunda	Sandberg Bluegrass	Native – VNS <sup>†</sup>	0.5	5
Sporobolus cryptandrus	Sand Dropseed	Native – VNS <sup>†</sup>	0.01	4
Stipa comata	Needleandthread Grass	Native – VNS <sup>†</sup>	0.7	5
Grass species subtotal			10.81	100
	<b>TOTAL PLS RATE</b>		<b>10.81</b>	<b>100</b>

\* PLS means Pure Live Seed; rates shown are for drill seeding, if broadcast, rates should be doubled.

\*\* Percent by seed number

\*\*\* Wetland mixes to be used only where wetland hydrology exists. Check with DIA Environmental Services.

† VNS = Variety Not Stated

Seeding shall be performed during the period between spring thaw and July 1 or between October 15 and the freezing of the ground unless otherwise approved by the DEN PM.

**901-2.2 Lime.** Not required.

**901-2.3 Fertilizer.** Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be a commercial fertilizer and shall be spread at the rate of which is determined by the seeding contractor and/or supplier to allow for proper vegetative growth.

**901-2.4 Soil for repairs.** The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the DEN PM before being placed.

## **CONSTRUCTION METHODS**

**901-3.1 Advance preparation and cleanup.** After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

**901-3.2 Dry application method.** Not required.

**c. Seeding.** Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked in, or drill seeded, within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

(1) If drill seeding is used, the seed drill will be equipped with three seed boxes including one for large smooth seed, one for fluffy seed (with picker wheels to prevent bridging), and one for small smooth seed. Furrow spacing may vary between 7 and 9 inches. Drill will have double disc furrow openers and functioning depth bands set to plant at ½ inch depth. Drill will have either packer wheels or drag chains. Grain drills are NOT acceptable. Seeder-cultipackers are also not acceptable.

(2) If broadcast seeding is used, soil surface will be roughened IMMEDIATELY prior to seeding using a toothed-type harrow. Seed will be spread by hand or by cyclonic spreader at a rate TWICE that specified for drill seeding in Tables 901-1 and 901-2. Immediately following seeding, the treated area will be harrowed with a tooth-type harrow to cover the seed. Sufficient passes will be made to assure that seed is covered to a depth of at least ¼ inch. Brush or chain-link drags are not acceptable for this purpose.

**d. Rolling.** After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

**901-3.3 Wet application method.** Not used.

**901-3.4 Maintenance of seeded areas.** The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the DEN PM. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the DEN PM. A grass stand shall be considered adequate when bare spots are one square foot or less, randomly dispersed, and do not exceed 3% of the area seeded.

### METHOD OF MEASUREMENT

**901-4.1** The quantity of seeding to be paid for shall be the number of units acre measured on the ground surface, completed and accepted.

### BASIS OF PAYMENT

**901-5.1** Payment shall be made at the contract unit price per acre or fraction thereof, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

Item T-901-5.1          Seeding - per acre

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602          Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC          JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33      Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-901**

## Item T-905 Topsoil

### DESCRIPTION

**905-1.1** This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the RPR.

### MATERIALS

**905-2.1 Topsoil.** Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 µm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

**905-2.2 Inspection and tests.** Within 10 days following acceptance of the bid, the RPR shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

### CONSTRUCTION METHODS

**905-3.1 General.** Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the RPR before the various operations are started.

**905-3.2 Preparing the ground surface.** Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other

means approved by the RPR, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

**905-3.3 Obtaining topsoil.** Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the RPR. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the RPR. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the RPR. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoil purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the RPR. The Contractor shall notify the RPR sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

**905-3.4 Placing topsoil.** The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turving operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the RPR. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

## **METHOD OF MEASUREMENT**

**905-4.1** Topsoil obtained on the site shall be measured by the number of cubic yards of topsoil measured in its original position and stripped or excavated. Topsoil stockpiled by others and

removed for topsoil by the Contractor shall be measured by the number of cubic yards of topsoil measured in the stockpile. Topsoil shall be measured by volume in cubic yards computed by the method of end areas. Any excess topsoil not used, shall be considered Unclassified Excavation.

### **BASIS OF PAYMENT**

**905-5.1** Payment will be made at the contract unit price per cubic yard for topsoil (obtained on the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item T-905-5.1          Topsoil (Obtained On-Site) - per cubic yard

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C117                  Materials Finer than 75  $\mu\text{m}$  (No. 200) Sieve in Mineral Aggregates  
by Washing

Advisory Circulars (AC)

AC 150/5200-33          Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-905**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM T-905 TOPSOIL**

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## Item T-908 Mulching

### DESCRIPTION

**908-1.1** This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the DEN PM.

### MATERIALS

**908-2.1 Mulch material.** Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

- a. **Wood-fiber Mulch.** Wood fiber mulch must be virgin long-fiber material. Wood fiber shall be absent of materials toxic to plant growth. Wood chips are not acceptable.
- b. **Matting.**
  - (1) **Covering.** Covering shall consist of blankets with close weave mesh and nettings with open weave mesh made of various materials as specified herein.
  - (2) Blankets and nettings shall be biodegradable, non-toxic to vegetation or germination of seed, and shall not be toxic or injurious to humans.
    - (a) **Excelsior.**

The blanket shall consist of a machine produced mat of curled wood excelsior of 80 percent, 6 inch or longer fiber length with a consistent thickness of fibers evenly distributed over the entire area of the blanket. The top side of the blanket shall be covered with a biodegradable netting, manufactured from a jute or other biodegradable material and stitched on 2-inch centers the entire width of the blanket.

Dimensions:                    48" by 180' or 96" by 90'

Roll Weight:                    0.9 to 1.1 pounds per sq. yd.
    - (b) **Soil Retention Blanket (coconut).** Soil Retention Blanket (Coconut) shall be a machine produced mat consisting of 100 percent coconut fiber. The blanket shall be of consistent thickness with the coconut fiber evenly distributed over the entire area of the mat. The blanket shall be sewn together with biodegradable thread.

Material Requirements:

Coconut Fiber Content:            100%, 0.50 to 0.60 lb. per sq. yd

**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM T-908 MULCHING**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
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Netting:	Both sides, biodegradable 9.3 lbs. per 1000 sq. ft.
Thread:	Biodegradable
Roll Width:	6.5 to 7.5 feet
Roll Length:	83.5 to 110 feet
<b>Area Covered by One Roll: 60 to 80 sq. yd</b>	

- (c) **Soil Retention Blanket (Straw).** Soil Retention Blanket (Straw) shall be a machine produced mat consisting of 100 percent agricultural straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with biodegradable netting having an approximate 5/8 inch x 5/8 inch to 1/2 inch x 1/2 inch mesh and on the bottom with biodegradable netting with an approximate 1/4 inch x 1/4 inch to 1/2 inch x 1/2 inch mesh. The blanket shall be sewn together with biodegradable thread.

Material requirements:

Straw Content:	100%, 0.50 lb. per sq. yd.
Netting:	Bottom side biodegradable, 9. lbs. per 1000 sq. ft.;
Netting:	Top side biodegradable, 9.3 lbs. per 1000 sq. ft.
Thread:	Biodegradable
Roll Width:	6.5 to 7.5 feet
Roll Length:	83.5 to 110 feet
Area Covered by One Roll:	60 to 80 sq. yds

A sample of the soil retention blanket (straw) shall be submitted at least 2 weeks in advance of its use on the project for approval by the Project Manager..

- (d) **Pins and Staples.** Pins and staples shall be made of wire 0.162 inch or larger in diameter. "U" shaped staples shall have legs 8 inches long and a 1 inch crown. "T" shaped pins shall not be used

c. Tackifier. Material for mulch tackifier shall consist of a free-flowing, organic, 100% all natural starch polymer, applied in a slurry with water and wood fiber

d. Stubble Mulch. Stubble mulch is the holdover debris of stems and leaves left from a small grain crop; these can function as mulch for a permanent seeding. One of the crop species below is used to establish a cover and mulch that functions as a standing mulch for subsequent seeding. NOTE: when using these species, the crop must be mowed to product stubble prior to producing seed.

**908-2.2 Inspection.** The DEN PM shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the

approval of the DEN PM and any materials brought on the site that do not meet these standards shall be rejected.

**908-2.3 Storage.** The Contractor shall store mulch with protection from weather or other conditions that would damage or impact the effectiveness of the product.

### **CONSTRUCTION METHODS**

**908-3.1 Mulching.** Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the DEN PM. Straw or hay shall be spread over the surface to a uniform thickness at the rate of 2 to 3 tons per acre (1800 - 2700 kg per acre) to provide a loose depth of not less than 1-1/2 inches (38 cm) nor more than 3 inches (75 mm). Other organic material shall be spread at the rate directed by the DEN PM. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches (150 mm) or more in length. When mulches applied by the blowing method are cut, the loose depth in place shall be not less than one inch (25 mm) nor more than 2 inches (50 mm).

**908-3.2 Securing mulch.** The mulch shall be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, matting, asphalt binder, or other adhesive material approved by the DEN PM. Where mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and will be held responsible for any such damage resulting from the operation.

If the “peg and string” method is used, the mulch shall be secured by the use of stakes or wire pins driven into the ground on 5-foot (1.5-m) centers or less. Binder twine shall be strung between adjacent stakes in straight lines and crisscrossed diagonally over the mulch, after which the stakes shall be firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

#### **908-3.3 Care and repair.**

**a.** The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the DEN PM, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

**b.** The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the DEN PM, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

**c.** If the “asphalt spray” method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100

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sq m), or as directed by the DEN PM, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it. Asphalt binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the asphalt material shall be required. A pump or an air compressor of adequate capacity shall be used to ensure uniform distribution of the asphalt material.

**d.** If the “asphalt mix” method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m) or as directed by the DEN PM, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it.

### **METHOD OF MEASUREMENT**

**908-4.1** Mulching shall be measured in square yards on the basis of the actual surface area acceptably mulched.

**908-4.2** Erosion Control Blankets shall be measured in square yards on the basis of the actual area of acceptably installed blankets.

### **BASIS OF PAYMENT**

**908-5.1** Payment will be made at the contract unit price per square yard (square meter) for mulching. The price shall be full compensation for furnishing all materials and for placing and anchoring the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item T-908-5.1	Mulching - per square yard
Item T-908-5.2	Erosion Control Blankets - per square yard

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D977	Standard Specification for Emulsified Asphalt
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Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports
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FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-908**

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**SECTION 221323 - SANITARY WASTE INTERCEPTORS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

Retain or delete this article in all Sections of Project Manual.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Oil interceptors.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of metal interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
  - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

**1.4 INFORMATIONAL SUBMITTALS**

Retain "Coordination Drawings" Paragraph below to require coordination of other trades involved in the installation of products listed below.

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Piping connections. Include size, location, and elevation of each.
  - 2. Interface with underground structures and utility services.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

## 1.6 FIELD CONDITIONS

Retain this article if interruption of existing sanitary or storm sewer service is required.

- A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of service.
  2. Do not proceed with interruption of sewer services without DEN PM's written permission.

## PART 2 - PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

### 2.1 OIL INTERCEPTORS

Indicate on Drawings the number, size, and arrangement of compartments and baffles in oil interceptors in. In "Precast-Concrete Oil Interceptors" Paragraph below, delete option and insert name(s) of authorities having jurisdiction for interceptors complying with requirements of authorities having jurisdiction.

- A. Steel Oil Interceptors: Factory fabricated and prepackaged; Underground Double-wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator(s). Separator shall be furnished with oil level alarm and leak detection
1. Inlet, Outlet, Vent, and Waste-Oil-Outlet Piping Connections: Hub, hubless, flanged or threaded unless otherwise indicated to connect into RCP pipes.
  2. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns
  3. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel (to the greatest extent possible with consideration to shipping requirements) ready for installation. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58. Tank design to comply with UL 2215 with coating systems both interior and exterior, electronic

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- monitoring system, coalescers size etc, effluent testing and verification the performance of the tank should be by the third party.
4. Separator shall consist of inlet and outlet connections, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, pre-settling area for solids, sludge baffle, oil coalescing chamber with removable parallel corrugated plates and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access manways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs. Dimensions of overall tank and each component refer to drawing.
  5. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi-hi oil level (audible and visual) of oil storage in the oil/water separator will be provided. An audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) to be intrinsically safe. Level sensor floats to be made of stainless steel. The control panel shall contain both level sensor and leak detection control. The control panel shall be NEMA 4. Power to the control panel is to be 120 volts/1 phase.
  6. Separator should be supplied with anchoring system that includes polyester or steel hold down straps and concrete Deadman anchors.
  7. External tank surfaces blasted and coated with 75 mils self-reinforcing polyurethane. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, Double-wall construction with 360-degree Steel Secondary Containment. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank must have a double steel shell without a defined space between the layers (UL Type I Double-wall). The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from the bottom of the shell.

"Extension" Subparagraph below is an optional feature. Retain only if required. Verify availability.

8. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
9. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C890, load.
10. Factory 10-year warranty for external corrosion and structure defects.
11. Level and leak sensors.
12. Two (2) 24-inch diameter manholes, UL approved, extensions to be completed based on the length based on burial depth, covers, gaskets, and bolts. One manway shall be placed between the inlet and the parallel-flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.

If more than one oil interceptor is required, delete "Capacities and Characteristics" Subparagraph below and schedule oil interceptors on Drawings.

13. Capacities and Characteristics:
- a. Capacity: 5,000 gallon and 6,000 gallon
  - b. Overall Dimensions: See Plan
  - c. Flow Rate: 450 gpm and 550 gpm
  - d. Inlet and Outlet Pipe Size: See Plan
  
  - e. End Connections: Flanged.
  - f. Waste-Oil-Outlet Pipe Size: 8" & 10".
  
  - g. Trapped Outlet Required: Integral.
  - h. Cleanout: Integral.
  - i. Mounting: On Concert Pad.
  - j. Flow-Control Fitting: Required.

### **PART 3 - EXECUTION**

#### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section

#### 3.2 INSTALLATION

- A. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

- 1. Install and oil interceptors on cast-in-place concrete equipment base(s).
  
- B. Set interceptors level and plumb.
  
- C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
  
- D. Set tops of manhole frames and covers flush with finished surface in pavements.
  - 1. Set tops 3 inches (75 mm) above finish surface elsewhere unless otherwise indicated.
  
- E. Set tops of grating frames and grates flush with finished surface.
  
- F. Set metal interceptors level and plumb.
  
- G. Set tops of metal interceptor covers flush with finished surface in pavements.
  - 1. Set tops 3 inches (75 mm) above finish surface elsewhere unless otherwise indicated.

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- H. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
- I. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.
  - 1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

**3.3 IDENTIFICATION**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Oil interceptors.

**3.4 PROTECTION**

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

**PART 4 - METHOD OF MEASUREMENT**

- 4.1 Oil interceptor (oil/water separator), shall be measured by the unit complete in place and accepted by the DEN PM.

**PART 5 - BASIS OF PAYMENT**

- 5.1 The accepted quantities oil/water separators will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item 221323-5.1     5000 Gal Oil/Water Separator - per each

Item 221323-5.2     6000 Gal Oil/Water Separator - per each

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**END OF SECTION 221323**

**SECTION 333123 - SANITARY SEWORAGE FORCE MAIN PIPING****PART 1 - GENERAL**

## 1.1 SUMMARY

## A. Section Includes:

1. Force mains.
2. PVC pipe.

## B. Related Requirements:

1. Section P-152 "Soils for Earthwork" for soil backfill from above pipe to finish grade.
2. Section P-152 "Aggregates for Earthwork" for aggregate for pipe bedding and cover.
3. Section P-152 "Trenching" for excavation, backfilling, compacting, and fill over underground pipe markers.
4. Section P-152 "Fill" for requirements for fill over underground pipe markers.

## 1.2 UNIT PRICES

## A. Pipe and Fittings:

1. Basis of Measurement: By linear foot (meter).
2. Basis of Payment: Includes excavation, backfill, bedding, thrust restraints, pipe and fittings.

## 1.3 COORDINATION

## A. Coordinate Work of this Section with connection to existing.

## 1.4 PREINSTALLATION MEETINGS

## A. Preinstallation Conference: Conduct conference at Project site.

## 1.5 SUBMITTALS

## A. Product Data:

1. Force mains.
2. PVC pipe.

## B. Shop Drawings:

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1. Indicate piping piece numbers and locations.
  2. Indicate restrained joint locations.
  3. Signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for restrained joints, including establishing lengths of restrained joint piping required.
- D. Field Quality-Control Reports: For piping.
- E. Qualifications Statements: For manufacturer, installer, and licensed professional.
- 1.6 CLOSEOUT SUBMITTALS
- A. Project Record Documents: Record invert elevations and actual locations of pipe runs and connections.
- 1.7 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.
- B. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience.
- C. Licensed Professionals Qualifications: Professional engineer experienced in design of specified Work and licensed at Project location.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Storage:
1. Store materials according to manufacturer instructions.
  2. Do not place materials on private property without written permission of property owner.
  3. Do not stack pipe higher than recommended by pipe manufacturer.
- C. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  2. Store gaskets for mechanical and push-on joints in cool and dry location, out of direct sunlight, and not in contact with petroleum products.
  3. Provide additional protection according to manufacturer instructions.

## **PART 2 - PRODUCTS**

### 2.1 PERFORMANCE REQUIREMENTS

- A. Perform Work according to:
1. The State of Colorado Department of Transportation standards.
  2. The Municipality of Denver Department of Public Works standards.
  3. standards.

### 2.2 PVC PIPE

- A. PVC Pressure Sewer Pipe and Fittings, 12-Inch (300-mm) Nominal Size and Smaller:
1. Comply with ASTM D2241.
  2. PVC 1220 (12454) or PVC 2120 (14333).
  3. SDR: 26.

### 2.3 MATERIALS

- A. Bedding and Cover:
1. Bedding: The bedding material shall be in accordance with item D-701-2.3 Bedding.
  2. Cover: Reuse existing in place.
  3. Soil Backfill from above Pipe to Finish Grade: Reuse existing in place.
  4. Subsoil: Reuse existing in place.

### 2.4 MIXES

- A. Concrete: As specified in Item P-610.

### 2.5 ACCESSORIES

- A. Pipe Markers: refer to 3.3 B). (5)

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that excavation base is ready to receive Work.

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- C. Verify that excavations, dimensions, and elevations are as indicated on Shop Drawings.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Correct over-excavation with fine aggregate.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- C. Remove large stones or other hard matter capable of damaging pipe or of impeding consistent backfilling or compaction.

**3.3 INSTALLATION OF PIPING**

- A. Bedding:
  - 1. Reuse bedding material at trench bottom.
  - 2. Maintain optimum moisture content of bedding material to attain required compaction density.
- B. Piping:
  - 1. Install pipe, fittings, and accessories as indicated on Drawings.
  - 2. Route piping in straight line.
  - 3. Install bedding at sides and over top of pipe to minimum compacted thickness of 8 inches.
  - 4. Backfilling and Compacting: (Reuse existing)
  - 5. Pipe Markers: Install detectable green warning tapes directly over piping and at outside edges of underground manholes.
- C. Thrust Restraints:
  - 1. Provide pressure pipeline with restrained joints or concrete thrust blocking at pumps, bends, tees, and changes in direction.
  - 2. Provide concrete thrust blocking of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than
  - 3. 2000 psi after 28 days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, place the base and thrust bearing sides of thrust blocks directly against undisturbed earth. Place the side of thrust blocks not subject to thrust against forms, if applicable. Provide the area of bearing as shown or as directed. Place blocking so that the fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.
- D. Cradles and Encasements: Reuse concrete cradles and encasements for pipelines where indicated on Drawings

**3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Request inspection by DEN PM on bedding prior to placing pipes.
- C. Pressure Testing:
1. Perform both a pressure test and a leakage test on all pipelines. Notify the DENPM at least 7 days in advance of equipment tests. Submit the final test report to the Contracting Officer within 30 days
  2. Pressure:
    - a. Not less than or 100 psi in excess of maximum static pressure, whichever is greater.
    - b. Maintain pressure within plus or minus 5 psi (34.4 kPa) of test pressure.
    - c. As indicated on Drawings.
  3. Time:
    - a. Conduct test for minimum of two hours.
  4. Initial Procedure:
    - a. Install corporation cocks at high points.
    - b. Slowly fill section to be tested with water, expelling air from piping at high points from air vents and by opening corporation cocks.
    - c. Close air vents and corporation cocks after air is expelled.
    - d. Raise pressure to specified test pressure.
  5. Testing:
    - a. Observe joints, fittings, and valves under test.
    - b. Remove and replace cracked pipes, joints, fittings, and valves showing visible leakage.
    - c. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
  6. Leakage:
    - a. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
    - b. Maximum Allowable Leakage:
      - 1)  $L = SD \times \text{sqrt}(P)/C$ .
      - 2) L = testing allowance, gph (L/h).
      - 3) S = length of pipe tested, feet (m).
      - 4) D = nominal diameter of pipe, inches (mm).
      - 5) P = average test pressure during hydrostatic test, psig (kPa).
      - 6) C = 148,000 (794 797).

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- c. If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
  - d. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
  - e. Correct visible leaks regardless of quantity of leakage.
- D. Perform pressure test on piping according to AWWA C605 standards.
- E. Compaction Testing:
- 1. Compaction testing per Item P-152.
- F. Prepare test and inspection reports.
- 3.5 PROTECTION
- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

#### **PART 4 - METHOD OF MEASUREMENT**

- 4.1 The length of pipe shall be measured in linear feet (m) of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. Each class, type and size of pipe shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured.

#### **PART 5 - BASIS OF PAYMENT**

- 5.1 These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, bedding, CLSM encasement, concrete encasement, backfill, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made at the contract unit price per linear foot for the following pipe installed complete in place, and accepted by the DEN PM:

Item 333123-5.1 8-Inch PVC DIW Force Main Pipe - per linear foot

**END OF SECTION 333123**

## ITEM L-100 LIGHTING AND ELECTRICAL WORK

### DESCRIPTION

**100-1.1 GENERAL.** The airfield electrical work to be done under this contract shall include the furnishing of all supervision, labor, materials, tools, equipment, and incidentals necessary to provide new airfield lighting system and other electrical work as shown on the drawings.

The electrical work shall comply with latest adopted editions, codes and standards applicable to this Contract as follows:

ICEA	Insulated Cable Engineers Association
ANSI C2	National Electrical Safety Code
ASTM	American Society of Testing and Materials
FAA	Advisory Circulars
FAA	Engineering Briefs
FAA	Orders
NECA	Standard for Installation
NEMA	Standard for Materials and Products
NFPA	National Electrical Code, 70
NFPA	Standard for Electrical Safety in the Workplace, 70E
NFPA	Life Safety Code, 101
OSHA	Occupational Safety and Health Administration, as Amended
UL	Underwriters Laboratories

All work shall be performed in strict accordance with these contract specifications, drawings, and any instructions that may be furnished by the DEN Project Manager during execution of the work to aid in interpretation of said drawings and specifications. Installation details and material and equipment specifications shall be in conformance with all applicable FAA Advisory Circulars, Orders and Engineering Briefs. The Contractor shall furnish written proof of FAA approval on all equipment covered by FAA specifications as part of the submittal package. The Contractor shall keep these specifications on file at their airport construction office.

**100-1.2 RELATED DOCUMENTS.** The general provisions of the contract apply to the work specified in Items L-100, L-108, L-109, L-110, L-115, L-125, L-140, and 13410A.

**100-1.3 SUMMARY OF WORK.** The work to be performed includes furnishing all labor, supplies, materials, equipment, transportation, and services required to augment, move, install, and complete electrical work as specified herein and as shown on the contract drawings.

The work includes, but is not limited to, the following:

**a.** Maintain in operation, all existing field electrical facilities and circuits while this improvement work is in progress, including protection of airport personnel, aircraft, and vehicles; furnish and maintain temporary circuits, and place augmented airport lighting into operation. Field lighting shall be operable each night, each day when fog conditions exist, , when the airport calls an emergency, or whenever the lighting system is deemed critical for use by Airport Operations or the FAA for safe operations of the airfield..

**b.** Provide underground cable (L-824) in accordance with specifications, at the locations shown on the plans. Test all circuit loops before and after installation of new cables to verify that no damage was caused by the Contractor.

**c.** Return to Owner or remove from the site, as directed by the DEN Project Manager, existing equipment that is to be removed or replaced.

**d.** Ground all equipment, enclosures, and conduits installed under this contract as shown on the plans, specifications or in accordance with the NEC whichever is more stringent.

**e.** Adjust finished grade as necessary to accommodate existing and new airfield equipment.

**f.** Other items required to complete foregoing. The omission of expressed reference to any parts necessary for or reasonably incidental to the complete installation shall not be construed as releasing the Contractor from furnishing and installing such parts.

**g.** In P-501 panel removal, asphalt removal or grading areas, the counterpoise conductor shall be tested prior to any work. The resistive value shall be documented and provided to the DEN Project Manager. At the completion of panel placement, the counterpoise shall be measured to be less than or equal to the value measured prior to demolition and witnessed by the DEN Project Manager. Counterpoise conductors shall be found to be continuous based on the resistive value (size and length) between locations such as light can to light can, manhole to light can, manhole to manhole, light can to ground rod, etc. Measurements shall be completed and demonstrated to the DEN Project Manager or designated representative before work is to proceed. Non-continuous counterpoise conductors shall be subject to removal of completed work and counterpoise repaired at no additional cost to the owner.

**h.** The Contractor shall inspect the conduit system prior to paving to assure the conduit is not damaged. The Contractor shall use an approved mandrel to proof the conduit system that runs through any panel replacement area; once panel replacement is completed the conduit shall have a mandrel pulled through the duct prior to re-installation of cable.

All items of general work required, such as excavation, cutting, patching, etc. shall be included in this Contract.

**100-1.4 WORK REQUIREMENTS.** The general work requirements are as follows:

- All work shall be scheduled to minimize the impact and duration of runway or taxiway shutdowns. The Contractor shall keep the DEN Project Manager informed of scheduled work which will affect existing equipment and operations. Minimum 10 working days advance notice shall be given to the DEN Project Manager and approval received for any disconnections or shutdowns.
- Existing lighting systems shall be operational at the end of each working day prior to nightfall except as permitted by the DEN Project Manager. Poor weather visibility or an emergency situation may require postponement of a scheduled shutdown on any given day.
- The plans are diagrammatic. Locations of equipment to be installed are shown in the plans, but the actual installation will depend on field conditions and the nature of the equipment furnished. When conditions which will adversely affect the installation become apparent, the DEN Project Manager shall be notified in writing.
- Locations and quantities of materials shown on the plans and in these specifications are approximate and shall be used for estimating purposes only. Actual locations and quantities of materials shall be reviewed by the Contractor through field investigation. No additional payment will be made for discrepancies between estimated quantities and locations of materials as shown in these documents and the actual field conditions.

The Contractor shall at all times keep the construction areas free from accumulations of waste material and rubbish, and prior to completion of work shall remove any rubbish from the project, as well as all tools, reels, equipment, and materials not a part of the project. Upon completion of the construction, the Contractor shall leave the work and premises in a clean, neat, and safe condition satisfactory to the DEN Project Manager. The Contractor shall be responsible for the proper performance in all respects, in whole and in part, of the electrical equipment and for the mechanical installation of electrical equipment until acceptance of the entire work by the DEN Project Manager.

**100-1.5 SUBMITTALS.** Submittals of all equipment and materials shall meet the requirements of Section 013300, Section 013325 and in accordance with this specification. Each submittal shall include no more than one spec section, i.e., each spec section shall be submitted under a separate submittal form as per Section 013300.

All materials and equipment used to construct this project shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Indicate all optional equipment and delete non-pertinent data. The Contractor is solely responsible for project delays accruing directly or indirectly from late submissions or resubmissions of submittals. This book shall include all fixtures and appropriate incidentals for each fixture to indicate to the DEN Project Manager that the Contractor comprehends the airfield lighting installation process.

The Contractor shall include wiring diagrams, cut sheets, brochures, etc. of all equipment used on the job, including, but not limited to the items listed in these specifications and in the format described herein. The submittal package will not be reviewed unless 100% complete.

The submittal shall consist of manufacturer's brochures and cut sheets describing the equipment and materials the Contractor plans to incorporate in the work. These sheets shall be sequentially ordered by specification number with the reference specification number shown on the bottom right of each sheet. Each cut sheet shall show the complete specification or drawing number with which the item must comply (i.e., L-108.2.03 and/or detail 3 on page EL-501). Clearly and boldly mark each copy to identify pertinent products or models applicable to this project.

In the one bound book, the cut sheets shall be organized by the specification item number (L-100, L-108, etc.) with a tabbed divider sheet separating each item section. The submitted cut sheet shall clearly show the equipment manufacturer's name, catalog number, size, type, and/or rating as required by these specifications or drawings by underlining or circling the information, highlighting is not acceptable. The conformance to FAA criteria or other standards where called for shall be clearly indicated for each item. Each sheet shall be dedicated to one piece of equipment, and all sheets shall be sequentially numbered (i.e., 1/50; indicating page 1 of 50 total pages). One manufacturer's cut sheet shall be submitted for each item. All sheets shall be 8-1/2" x 11" or 17" x 11". When these sizes are unpractical, a folded 24" x 36" drawing may be substituted. All drawings shall be to scale. All sheets shall be bound in a 3-ring binder. Each submittal shall show on the cover the complete job name and number, date, Contractor's name, and the words: "Electrical Submittal." The checklist shown in this specification shall be included as the first sheet of each submittal and shall show the page number of each item included in the submittal. Additional items to be submitted which are not on the list shall be added to the bottom of the table.

Samples of conduit, duct, fittings, cables, tapes, fixtures, etc., may be requested by the DEN Project Manager or required in these specifications. After they have been

reviewed, samples will be returned in tested condition to the Contractor. In the event any items of material or equipment contained in the list fail to comply with specification requirements, such items will be rejected. All rejected items shall be amended to meet the criteria and then resubmitted for approval by the DEN Project Manager.

Substitutions of materials referenced herein is allowed when "or equal" is referenced. Any substitution shall be included in the submittal package and contain additional information as required by Section 016000.

All methods and shop drawings of installations shall be submitted and approved prior to the start of installation for each phase of work.

Contractor's liability to the City, in case of variations in the submittal document from the requirements of the contract documents is not relieved by the City's review and acceptance of submittals containing variations unless the City expressly approves the deviations in writing, in which the City describes the variation.

**100-1.6 DRAWINGS.** The plans, which constitute an integral part of this Contract, shall serve as the working drawings. They indicate the extent and general layout of the lighting and signing system, arrangement of circuits, cables through ducts, and connections to existing circuit cables, and other work. Field verification of scale dimensions is required to determine actual locations, distances, and levels. The Contractor shall research in the field the exact routing and identification of all circuits which extend through, serve, or are affected by the area where work is to commence. No extra compensation will be allowed because of minor differences between work shown on the drawings and field conditions. The Contractor shall check the plans and specifications and, if any portion of the work is found to be omitted, unclear, or in error, the Contractor shall immediately notify the DEN Project Manager. The directions of the DEN Project Manager shall be followed and the work completed accordingly. The design drawings may be utilized in the preparation of the shop or working drawings showing the permanent construction, as described in L-100.

The plans and specifications are complementary and what is called for in either one shall be as binding as if called for in both.

Where a disagreement exists between the plans and specifications, the item or arrangements of better quality, greater quantity, or higher cost shall be included in the bid.

Any discrepancies between the drawings, Advisory Circulars, and field conditions must be resolved with the DEN Project Manager before proceeding. All agreements shall be verified in writing.

'Record' drawings covering equipment installed under previous contracts and which relate to this contract will be available for the Contractor. The airport cannot,

however, guarantee the accuracy of these drawings. Those conditions which will affect the work under this contract should be verified prior to any design/fabrication/installation commitment.

Detail dimensions shown on the plans are approximate and shall be field verified before construction. All differences shall be submitted to the DEN Project Manager in writing before construction begins.

**100-1.7 RECORD DRAWINGS.** The Contractor shall mark up a set of blue line prints to show the as-built conditions which differ from the contract plans. All changes shall be recorded by a skilled draftsman with at least three years of CAD experience. The DEN Project Manager will furnish a newly printed set of blue line drawings to be used for this purpose. Record drawings will be checked periodically for accurateness and partial payments will be withheld until the record drawings are completely updated. The mark-up set shall be kept at the site, and any changes, discoveries, or deviations shall be recorded daily. The Contractor shall furnish one newly printed as-built drawing set to the DEN Project Manager upon completion. This work shall be completed and accepted by the DEN Project Manager before approval of final payment. The Contractor shall include complete as-built drawings with Northing/Easting coordinates and elevations of duct banks installed. The Contractor shall document all return splice locations and complete wiring diagrams including the actual field configuration of circuits.

**100-1.8 MAINTENANCE AND OPERATING INSTRUCTIONS.** The Contractor shall provide the Owner with complete instructions in the proper care and operation of the equipment installed under this contract. This is considered as part of the final inspection, and final acceptance will not be given until the Owner's representative is knowledgeable about the system.

The Contractor shall also collect and assemble into each of three hardcover books and three CDs the installation details, instructions, parts list, source of local supply, schematics of actual equipment and operations, and directions supplied by the manufacturer with all equipment. If cut sheets are included showing various models and features of the equipment supplied, the specific model and features shall be clearly indicated to show only the options of the equipment that are actually provided and installed. Final acceptance of the work will be withheld until such data has been presented complete to the DEN Project Manager for transmission to the Owner. The Contractor shall comply with Section 017825 Operation and Maintenance Data.

The Contractor shall install all equipment according to the manufacturers' instructions and as shown in the drawings and specifications. The Contractor shall notify the DEN Project Manager in writing if any discrepancies exist between the aforementioned documents. Work shall be suspended until resolved and approval to proceed has been granted by the DEN Project Manager.

**100-1.9 SAFETY RULES.** The Electrical Safety Rules shall be observed and complied with in every detail, and any violation thereof shall be cause for immediate

termination of the Contractor's authority to proceed with the work and recourse to their Surety for completion of the Project. The Electrical Safety Rules are as follows:

The Contractor shall be responsible for conforming to the safety requirements of AC 150/5370-2, AC 150/5340-30, NFPA/NEC, as well as local building and electrical codes.

Electrical circuits, operating over 300 volts, phase-to-ground shall be de-energized before work is accomplished thereon. Work on energized systems shall be accomplished by trained personnel, properly insulated, and done with extreme caution.

Electrical circuits shall be considered de-energized only when one of the following conditions exists:

- Switches connecting subject circuit to the electrical supply are observed in the OPEN position, with an air break, and safety-tagged (padlocked) in the OPEN position;
- Electrically operated switches are visibly OPEN, blocked or racked in the OPEN position, and safety-tagged OPEN;
- Whenever the supply circuit breaker is not visible and clearly identified, the circuit shall be grounded. The ground connection shall be safety-tagged before work thereon, when the ground connection is not within sight of the work area.
- Oil switches observed OPEN in a sight window, and tagged OPEN; or oil fuse cutouts with fuse carrier removed and tagged OPEN.
- For airfield lighting circuits fed by constant current regulators, the disconnect switches feeding all affected regulators and power circuits leaving the vault shall be locked in the OPEN position. When working in manhole housings, additional circuits not a part of the project, those circuits shall be locked in the OPEN position as well. The circuits shall be put into maintenance lock out on the control system with the assistance of the project management team prior to lock out of the regulator.

**a. Use of Red Safety Tags:** Safety tags shall be filled out daily and connected to any switch or equipment opened for protection of personnel working upon circuits connected thereto.

Safety tags shall be removed only by the employee who placed the tag, or by another employee designated in writing by the employee who placed the tag, to remove the tag. Removal of a safety tag placed by an employee not available at the time of need to remove may be authorized by the Electrical Superintendent or his

designated representative, only after carefully checking that the circuit is ready to be energized.

Equipment with a safety tag attached shall not be operated, and connections with a safety tag attached shall not be changed.

Insulated cables, operated at over 300 volts to ground shall be handled, when energized, only with rubber gloves tested to 15,000 volts.

Insulated cables, which have been in operation, shall be cut only with grounded cable shears, or shall be grounded by driving a grounded sharp tool through the shielding and the conductors before cutting.

All personnel working around energized electrical equipment operating at over 600 volts shall wear standard insulated, non-conducting hard hats, and shall wear no garments with metallic zipper fasteners, and remove all jewelry.

Ladders used in any electrical work shall be of wood or fiberglass construction.

The Contractor shall designate a supervisor for all contract personnel and operations; said supervisor shall be present at the job site wherever contract operations are in progress.

## **EQUIPMENT AND MATERIALS**

**100-2.1 GENERAL.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified by independent laboratory testing to be in compliance with the specification, at the date of the Contractor's bid submission.

Equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the DEN Project Manager. Whenever Underwriters Laboratories has a published standard applicable to the equipment furnished for this contract, the furnished equipment shall be listed by UL. The term 'Equipment' shall be as defined in the NEC.

Materials and equipment shall be as specified herein. When materials are used that are not specifically designated herein, they shall be in accordance with the best industry standards and practices for equipment of this type. All components and parts shall be suitable for operation under the environmental conditions specified herein. Metal parts shall be either inherently corrosion-resistant or shall be suitably protected to resist corrosion or oxidation during extended service life.

**100-2.2 HARDWARE AND CORROSION PROTECTION.** In order to prevent deterioration due to corrosion, all bolts, nuts, studs, washers, pins, terminals, springs, hangers and similar fastenings and fittings shall be of an approved corrosion-resisting material and/or be treated in an approved manner to render it

adequately resistant to corrosion. All hardware such as cap screws, set screws, tap bolts, nuts, washers, etc., shall be of stainless steel type 304, SAE grade 2, if they are used outdoors unless specified otherwise on the plans. Brass, bronze, or hot-dip galvanized ferrous hardware (per ASTM, Specification A1530) will be considered for indoor use. All stainless steel and galvanized steel bolts, screws, nuts, etc., shall be coated with a layer of anti-seize compound.

All ferrous metalwork shall be hot-dip galvanized. If any galvanizing is damaged, the metal work shall be refinished by cleaning, treating with one coat of wash primer conforming to Federal (military) Specification MIL-P-152388, and shall be given one shop coat of zinc-rich base paint (zinc dust paint) conforming to Federal Specification TT-P-641F Type II, immediately when the wash primer is dry.

**100-2.3 PARTS RATING.** All parts shall be of adequate rating for the application and shall not be operated above the parts manufacturer's recommended ratings.

**100-2.4 ENVIRONMENTAL CONDITIONS.** The equipment installed outdoors shall be designated for continuous outdoor operation under the following environmental conditions unless specified elsewhere:

- a. Temperature: any ambient temperature from minus 20°F to plus 120°F.
- b. Altitude: 6000 MSL.
- c. Humidity: up to 100 percent.
- d. Sand and Dust: exposure to windblown sand and dust particles.
- e. Wind: operation at wind velocities up to 200 miles per hour.
- f. Water: components provided for underground installation, direct buried or installed in underground housing, shall be suitable for continuous operation, continuously or intermittently submerged in water.
- g. Chemical: shall be rated for exposure to all de-icing and anti-icing agents.

**100-2.5 SALVAGE.** Except as otherwise specified or indicated on the drawings, all electrical materials and equipment to be salvaged, removed, or "stored" shall become the property of the airport, and shall be moved by the Contractor to a site at the airport or within 5 miles of the airport designated by the DEN Project Manager. All wastes such as removed asphalt, concrete, excess dirt, conductors, damaged base cans, etc., shall become property of the Contractor and shall be disposed of off site by the Contractor.

**100-2.6 TESTING.** All materials and finishes are subject to testing. Material inspection and testing, and strength tests on the concrete will be performed by the Contractor at no expense to the airport other than material used. The Contractor shall assist the DEN Project Manager in obtaining samples during the course of construction work. The testing of electrical equipment shall conform to the description of the individual specification sections.

**100-2.7 INSPECTION.** Provide for electrical inspections by the DEN Project Manager. No work shall be concealed or enclosed until after inspections. If work is concealed or enclosed without inspection and approval, the Contractor shall be responsible for all expense and work required to open and restore the concealed area in addition to all required modifications.

Mill inspection will be waived, and the materials accepted upon certified copies of mill reports identifying the material specification requirements. Copies of order bills and test reports shall be furnished as requested.

**100-2.8 WARRANTY.** The Contractor shall provide a written 2-year warranty guaranteeing all work installed under this contract. It shall cover all parts and labor against defective parts, corrosion or workmanship necessary to repair or bring into proper operation any equipment including, but not limited to, isolation transformers, lamps, inset and elevated lighting fixtures, poles, conduit system, and junction boxes. This warranty work includes the Contractor to be on-site to remove, replace and ship any defective equipment discovered during the warranty period. At the end of the 2-year warranty period, the insulation resistance of each circuit shall be measured to a minimum of 750 Mohms according to the testing requirements per Item L-108. The warranty shall start upon the final acceptance of all work as accepted by the DEN Project Manager. Final payment will be withheld until receipt of the warranty by the DEN Project Manager.

LED fixtures shall have a written 4 year warranty provided as required by FAA Engineering Brief 67 (latest edition).

## **CONSTRUCTION METHODS**

**100-3.1 GENERAL.** Installation shall be performed by experienced and skilled persons to obtain only the best workmanship. All equipment shall be set square and true with construction. The work shall be under constant supervision by the Contractor, or by an authorized and competent foreman with five years airfield experience, until completion. The installation and adjustments shall be by competent Colorado State recognized licensed journeyman electricians. The Contractor shall include no more than one certified apprentice per journeyman electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.

All work shall be inspected by the Contractor's electrical QC. The electrical QC shall be responsible to correct or stop work when items of installation are found not to the

contract documents. The number of inspectors shall be adequate to cover all work areas during all phases of construction. The electrical QC inspector shall be submitted under the electrical QC Manager Plan, per Section 014310.

**100-3.2 INSTALLATION METHOD.** The methods used for the installation of electrical system and equipment shall conform to the National Electric Contractors Association (NECA) published "Standard of Installation" except where specifically specified or shown otherwise, and to the requirements of the National Electrical Code (NEC) and its revisions.

All electrical materials, construction methods, and installation shall be in accordance with applicable Federal Aviation Administration's advisory circulars including amendments, the National Electrical Code, and the American National Standards Institute Standard C2.

Workmanship shall be consistent with the best commercial practices for installation of this type. The workmanship shall be first class and in accordance with the highest standards of the electrical industry.

The responsibility for the correct and satisfactory installation and operation of all materials and equipment required herein shall rest with the Contractor. Before any equipment is ordered, a complete schedule of materials and detailed shop drawings covering all items of equipment and brochures of the materials proposed for installation shall be submitted for approval by the DEN Project Manager as described in Item L-100.

**100-3.3 SITE CONDITIONS.** At least five working days prior to commencing construction operations in an area which may involve underground utility facilities, the Contractor shall notify the DEN Project Manager and the owners of each underground utility facility shown on the plans. The FAA will assist the Contractor in locating FAA cables.

The existence of any known buried wires, conduits, junction boxes, ducts, or other facilities is shown in a general way only. It will be the duty of the Contractor, with the help of airport personnel, to visit the site and make exact determination of the existence and location of any facilities prior to commencing any work. It is understood that the Contractor will be responsible for making the exact determination of the location and condition of such facilities. Any costs shall be paid for by the Contractor. The Contractor shall obtain from the DEN Project Manager copies of contract drawings from previous construction projects, and examine these drawings and verify at the site the location of all below grade utilities in the vicinity of the work performed under this contract.

All items damaged by the Contractor's workers or equipment shall be replaced immediately at the Contractor's expense.

**100-3.4 INTERRUPTIONS.** Interruptions of lighting circuits may be necessary during construction. The Contractor shall provide a reliable shunt cable to provide temporary continuity of circuit service to runway and taxiway lights and signs during construction where required. The Contractor shall not interrupt any circuit or perform any work that might endanger any circuit until approval of the DEN Project Manager has been received. Temporary cables shall be installed in conduit and identified as a hazard.

The Contractor shall be responsible for installing, maintaining, protecting, and removing all required temporary jumper cables used to maintain power to electrical circuits.

For the permanent installation, all temporary connections and rerouting of circuits shall be replaced with new materials installed in accordance with the specifications and as shown on the plans.

See Item L-100, paragraph SAFETY RULES. Payment for this work will be made under Item L-108, Temporary Electrical Work/Jumpers when indicated. Otherwise the work shall be considered incidental.

If requested by the Project Manager, Contractor shall submit for approval an Operational Safety Plan (OSP) including circuits to be locked off and signs to be covered during construction.

**100-3.5 CODES.** The Contractor shall comply with all ordinances, laws, regulations, and codes applicable to the work involved and as referenced in these specifications. This does not relieve the Contractor from furnishing and installing work shown or specified which may be beyond the requirements of such ordinances, laws, regulations, and codes.

**100-3.6 SAFETY AREA.** The Contractor shall abide by the requirements of the contract specifications when working within the runway or taxiway safety areas or as directed by the DEN Project Manager.

### **METHOD OF MEASUREMENT**

**100-4.1** There shall be no separate measurement made for items in L-100. The work associated with the specification shall be considered incidental to other items of work.

### **BASIS OF PAYMENT**

**100-5.1** There shall be no separate payment made for items in L-100. The work associated with the specification shall be considered incidental to other items of work.

### **MATERIAL REQUIREMENTS**

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM L-100 LIGHTING AND ELECTRICAL WORK**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

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AC 150/5370-2      Operational Safety on Airports During Construction  
AC 150/5370-10    Standards for Specifying Construction of Airports  
MIL-P-152388      Wash Primer Specification  
TT-P-641F          Type II, Base Paint, Zinc-Rich

**END OF ITEM L-100**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-100 LIGHTING AND ELECTRICAL WORK**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item L-108 Underground Power Cable for Airports

### DESCRIPTION

**108-1.1** This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the DEN Project Manager. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

### EQUIPMENT AND MATERIALS

#### 108-2.1 General.

**a.** Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the DEN Project Manager.

**c.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the DEN Project Manager) and replaced with materials that comply with these specifications at the Contractor's cost.

**d.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**e.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format. The DEN Project Manager reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 108-3.10e with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested in accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

**108-2.2 Cable.** Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge (AWG), L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type THWN-2, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

**108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods).** Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for grounding bond wire per ASTM B3 and ASTM B8, and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper-clad. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 10 feet (2.54 m) long and 3/4 inch (19 mm) in diameter.

**108-2.4 Cable connections.** In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

**a. The cast splice.** A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, "Scotchcast" Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.

**b. The field-attached plug-in splice.** Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall be in accordance with the manufacturer's requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

**c. The factory-molded plug-in splice.** Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

**d. The taped or heat-shrink splice.** Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer's recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

**108-2.5 Splicer qualifications.** Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the DEN Project Manager proof of the qualifications of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

**108-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**108-2.7 Flowable backfill.** Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**108-2.8 Cable identification tags.** Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

**108-2.9 Tape.** Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

**108-2.10 Electrical coating.** Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

**108-2.11 Existing circuits.** Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the DEN Project Manager. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the DEN Project Manager. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the DEN Project Manager. The Contractor shall record the results on forms acceptable to the DEN Project Manager. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

**108-2.12 Detectable warning tape.** Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

## **CONSTRUCTION METHODS**

**108-3.1 General.** The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Cable shall be run without splices, from fixture to fixture.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the DEN Project Manager or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the DEN Project Manager.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

**108-3.2 Installation in duct banks or conduits.** This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the DEN Project Manager of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the DEN Project Manager prior to any cable installation. If required by the DEN Project Manager, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the DEN Project Manager. Cable pull tensions shall be recorded by the Contractor and reviewed by the DEN Project Manager. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's

recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the DEN Project Manager, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

**108-3.3 Installation of direct-buried cable in trenches.** Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted.

Where cables must cross over each other, a minimum of 3 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

**a. Trenching.** Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

- When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.
- Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

The Contractor shall excavate all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill material may alternatively be used.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

**(1)** Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

**(2)** Trenching, etc., in cable areas shall then proceed, with approval of the DEN Project Manager, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

**b. Backfilling.** After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall encompass all cables ; be 3 inches (75 mm) deep, loose measurement; and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25.0 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent material. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be per the requirements of Item P-152.

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of per the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the DEN Project Manager. If not shown on the plans, the warning tape shall be located 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 3-6 inch (75 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 inches (200 mm) minimum below finished grade.

**c. Restoration.** Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the topsoiling, seeding, and mulching as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be to a minimum of 100 percent of ASTM D1557. Restoration shall be considered incidental to the pay item of which it is a component part.

**108-3.4 Cable markers for direct-buried cable.** The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10 - 15 cm) thick, extending approximately one inch (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (61 m)

along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word “CABLE” and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep. Stencils shall be used for cable marker lettering; no hand lettering shall be permitted.

At the location of each underground cable connection/splice, except at lighting units, or isolation transformers, a concrete marker slab shall be installed to mark the location of the connection/splice. The Contractor shall impress the word “SPLICE” on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the DEN Project Manager. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the DEN Project Manager. Furnishing and installation of cable markers is incidental to the respective cable pay item.

**108-3.5 Splicing.** Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

**a. Cast splices.** These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer’s instructions and to the satisfaction of the DEN Project Manager.

**b. Field-attached plug-in splices.** These shall be assembled per the manufacturer’s instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

**c. Factory-molded plug-in splices.** These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

**d. Taped or heat-shrink splices.** A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminants prior to application.

**e. Assembly.** Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

**108-3.6 Bare counterpoise wire installation for lightning protection and grounding.** If shown on the plans or included in the job specifications, bare solid [ #6 AWG ] copper counterpoise wire shall be installed for lightning protection of the underground cables. The DEN Project Manager shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

**a. Equipotential.** The counterpoise size is as shown on the plans. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches (200 mm) minimum or 12 inches (300 mm) maximum above the raceway or cable to be protected, except as permitted below:

**(1)** The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

**(2)** The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

**b. Isolation.** Not used

c. Common Installation requirements. When a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

**d. Parallel Voltage Systems.** Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

**108-3.7 Counterpoise installation above multiple conduits and duct banks.** Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

**108-3.8 Counterpoise installation at existing duct banks.** When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

**108-3.9 Exothermic bonding.** Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the DEN Project Manager. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the DEN Project Manager, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

a. All slag shall be removed from welds.

b. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See AC 150/5340-30 for galvanized light base exception.

c. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

**108-3.10 Testing.** The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the DEN Project Manager. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the DEN Project Manager. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

a. Earth resistance testing methods shall be submitted to the DEN Project Manager for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the DEN Project Manager. All such testing shall be at the sole expense of the Contractor.

b. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The DEN Project Manager shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the DEN Project Manager the following:

a. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.

b. That all affected circuits (existing and new) are free from unspecified grounds.

c. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than 2,000 megohms. Verify continuity of all series airfield lighting circuits prior to energization.

d. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.

e. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.

f. That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

g. That the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the DEN PROJECT MANAGER prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the DEN PROJECT MANAGER. Where connecting new cable to existing cable, insulation resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved “repair” procedures for items that have failed testing other than complete replacement.

### **METHOD OF MEASUREMENT**

**108-4.1** The cost of all excavation, backfill, dewatering and restoration regardless of the type of material encountered shall be included in the unit price bid for the work.

**108-4.2** Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet (meters) installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed in trench, duct bank or conduit. The measurement for this item shall include additional quantities required for slack.

**108-4.3** No separate payment will be made for ground rods.

**108-4.4** No separate measurement shall be made for green insulated ground conductor but shall be incidental to the installation of each phase/neutral conductor, as required.

### **BASIS OF PAYMENT**

**108-5.1** Payment will be made at the contract unit price for cable and counterpoise wire installed in duct bank, conduit, or trench, or cable including equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals, including ground rods and ground connectors and trench marking tape, necessary to complete this item.

Payment will be made under:

Item L-108-5.1	Install Cable, 1/C #8 AWG, FAA L-824, Type C, 5,000V – per linear foot
Item L-108-5.2	Install Bare Copper Counterpoise, #6 AWG, Including Connections/Terminations and Ground Rods – per linear foot
Item L-108-5.3	Install Cable, 1/C #6 AWG THWN-2, 600V – per linear foot
Item L-108-5.4	Install Cable, 1/C #4/0 AWG THWN-2, 600V – per linear foot

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## Advisory Circulars (AC)

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program

## Commercial Item Description

A-A-59544A	Cable and Wire, Electrical (Power, Fixed Installation)
A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

## ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

## Mil Spec

MIL-PRF-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

## National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems

## American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
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## Federal Aviation Administration Standard

FAA STD-019E	Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment
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**END OF ITEM L-108**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-108 UNDERGROUND POWER CABLE FOR AIRPORTS**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item L-109 Airport Lighting Vault Equipment

### DESCRIPTION

**109-1.1** This item shall consist of procurement and installation of constant current regulators, circuit selector switches, step-up transformers, and associated equipment installed in the airport lighting vault in accordance with this specification, any referenced specifications, and the applicable Federal Aviation Administration (FAA) Advisory Circulars (ACs). The equipment shall be installed at the locations and in accordance with the dimensions, layout, design, and details shown in the plans. This item shall include furnishing and installing all equipment, wiring, electrical busway equipment, circuit breakers, cable, conduit, grounding systems, cable connections, marking and labeling of equipment, labeling or tagging of wires, testing of the installation and all incidentals and appurtenances necessary to place the systems in operation as completed units to the satisfaction of the DEN Project Manager

### EQUIPMENT AND MATERIALS

#### 109-2.1 General.

**a.** Airport lighting equipment and materials covered by advisory circulars (AC) shall be certified in AC 150/5345-53, Airport Lighting Equipment Certification Program (ALECP) and listed in the ALECP Addendum.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the DEN Project Manager.

**c.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the DEN Project Manager) and replaced with materials that comply with these specifications at the Contractor's cost.

**d.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**e.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be provided in electronic pdf format, tabbed by specification section. The DEN Project Manager reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

### **INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING**

**109-3.1 General.** The Contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to ensure a complete and operable electrical distribution center for the airport lighting system as specified herein and shown in the plans. When specified, an emergency power supply and transfer switch shall be provided and installed.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction. All electrical work shall comply with the NEC and local code agency having jurisdiction including the separation of under 600V work from 5,000V work.”

**109-3.2 Contract Drawings.** Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed, even though some minor details are not shown, the Contractor shall furnish all equipment, material, and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation. Further, the Contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with the civil plans.

**120-3.3 Minor Departures.** Minor departures from exact dimensions shown on the electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensional item, provided contract requirements are met. The Contractor shall promptly obtain approval from the DEN Project Manager prior to undertaking any such proposed departure.

**109-3.4 Power supply equipment.** Transformers, regulators, booster transformers, and other power supply equipment items shall be furnished and installed at the location shown in the plans or as directed by the DEN Project Manager. The power supply equipment shall be set on steel “H” sections, “I” beams, channels, or concrete blocks to provide a minimum space of 1-1/2 inch (38 mm) between the equipment and the floor. The equipment shall be placed so as not to obstruct the oil-sampling plugs of the oil-filled units; and name-plates shall, so far as possible, not be obscured.

If specified in the plans and specifications, equipment for an alternate power source or an emergency power generator shall be furnished and installed. The alternate power supply installation shall include all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set shall be the size and type specified.

**109-3.5 Switchgear and panels.** Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items shall be furnished and installed at the location shown in the plans or as directed by the DEN Project Manager. Wall or ceiling mounted items shall be attached to the wall or ceiling with galvanized bolts of not less than 3/8-inch (9 mm) diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

**109-3.6 Duct and conduit.** The Contractor shall furnish and install square-type exposed metallic ducts with hinged covers for the control circuits in the vault. These shall be mounted along the walls behind all floor-mounted equipment and immediately below all wall-mounted

equipment. The hinged covers shall be placed to open from the front side with the hinges at the front bottom.

Wall brackets for square ducts shall be installed at all joints 2 feet (60 cm) or more apart with intermediate brackets as specified. Conduit shall be used between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors shall enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

**109-3.7 Wiring and connections.** The Contractor shall make all necessary electrical connections in the vault per the wiring diagrams furnished and as directed by the DEN Project Manager. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

**a. General.** Unless otherwise indicated, wiring shall consist of insulated copper conductors installed in RGSC or LFMC as shown on the Drawings. All neutral conductors shall extend from the neutral bus in the device where the active conductors originate. Device terminals for connection of more than one conductor shall be specifically designed for that purpose.

**b. Raceway System.** Minimum conduit size shall be 3/4-inch. Each run shall be complete, and shall be finished and swabbed before conductors are installed. Ends of conduit systems not terminated in boxes or cabinets shall be capped. Existing conduits shall be cleaned and swabbed before cables are pulled.

**(1) Field Cutting.** Where conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. The cut ends of the field-cut conduit shall be reamed to remove burrs and sharp edges. Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory cut threads on conduit. If field threaded conduits are to be installed underground, oil shall be cleaned from threads before applying a cold galvanizing compound. Conduits installed with threads not complying with these requirements shall be removed and replaced with conduits that comply.

**(2) Conduit Installation.** Conduit shall be installed parallel to or at right angles with the lines of the structures unless shown otherwise on the Drawings. Field bends shall be avoided where possible, but, where necessary, shall be made with an approved conduit-bending device. Radius of field bends shall be not less than 10 times the inside diameter of the conduit. Conduits shall be plugged during construction to prevent entrance of foreign material. Both ends of all conduits entering a junction box from below grade shall be sealed with a non-curable duct seal compound.

**(3) Rigid Galvanized Steel Conduit.** RGSC shall be used in all locations. All fittings for use with rigid galvanized steel conduit shall be of the threaded type of the same material as the conduit. Where conduits enter boxes or cabinets without threaded hubs, double locknuts shall be used plus an insulated metallic bushing on the open end.

**(4) Liquid tight Flexible Metal Conduit.** LFMC shall be used outdoors/indoors or in wet locations. Lengths of LFMC shall meet the requirements of the National Electrical Code. A separate ground conductor shall be provided across all flexible connections in addition to the green wire ground.

**(5) Unapproved Conduit.** Conduit systems such as flexible metal steel conduit, electrical non-metallic tubing, electrical metallic tubing, armored cable, and metal-clad cable shall not be allowed.

**c. Conductors.**

**(1) Color-Coding.** All branch circuit and feeder conductors shall be color coded as specified in the National Electrical Code (NEC). The color-coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable in any part of the installation. The equipment-grounding conductor shall be covered with green insulation or shall be bare copper as specified herein. Neutral conductors shall be continuous white unless more than one system is run in the same raceway, box, or other type enclosure. Where color-coding is not available in the larger size conductors (larger than #6 AWG), the conductors shall be color-coded by use of color-coded tape, half lapped for a minimum length of 3-inches. Where conductors are color-coded in this manner, they shall be color-coded in all junction boxes, outlets, and switches, as well as at all terminations.

**(2) Conductor Identification.** In addition to color coding, all line, phase, and neutral conductors shall be identified by self-laminating, self-sticking printed labels, permanently attached stamped metal foil markers, or equivalent means as approved by the DEN Project Manager. Panel and circuit numbers shall be identified. Conductor identification shall be provided at all terminations, and in all junction boxes through which these conductors pass.

In addition to color-coding, control circuit conductor identification shall be made by self-laminating, self-sticking printed labels, permanently attached stamped metal foil markers, or equivalent means as approved by the DEN Project Manager. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

**d. Quality Control Provisions.**

**(1) Cable Tests.** All cable testing shall be done by the Contractor in the presence of the DEN Project Manager. The Contractor shall provide all test equipment and power. Equipment shall have been calibrated within 2 years. Cables shall be tested in the following order: upon delivery to the site; again prior to installation; after each splice during installation; and again upon completion of backfill operations. The Contractor shall immediately report any physical defects detected by cable testing to the DEN Project Manager.

**(a) 600-Volt Cable Test.** After they are installed but prior to completion of final connections, conductors, splices, and insulation shall be tested at not less than 500 volts DC for one minute. The minimum resistive value shall be 30 megohms between conductors and between conductors and ground.

**(b) Control Cable Tests.** Control cables shall be tested at not less than 500 volts DC for one minute. The minimum resistive value between conductors and from each conductor to grounded shield shall be 50 megohms.

**(2) Failure of Cable Under Test.** Cable failing tests prior to installation shall not be installed. Cables which pass the initial upon delivery testing, but fail after the Contractor takes possession shall be repaired or replaced by the Contractor at no additional cost.

**(3) Ground Resistance Test.** When new equipment is being installed, the existing grounding electrode system for each airfield electrical vault shall be tested. Ground resistance of the ground rod system shall not exceed 10 ohms. Ground resistance measurements shall be made in normally dry weather and not less than 72 hours after rainfall. If the desired resistance value is not obtained, additional rods shall be driven at least 10-feet apart until resistance values are obtained. Testing shall be by "fall of potential" method of IEEE 81 using Fluke, Biddle, Megger, or equivalent earth testers.

**(4) Quality Assurance.** All electrical equipment and materials provided by the Contractor shall be in accordance with this specification and be approved by Underwriters' Laboratories (UL), Inc. Original and two copies of tabulated results of all cable tests and ground resistance test performed under this section shall be forwarded to the DEN Project Manager for approval.

**109-3.8 Marking and labeling.** All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

**a. Wire identification.** The Contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification -markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4 inch (19 mm) in diameter and not less than 1/32 inch (1 mm) thick. Identification markings designated in the plans shall be stamped on tags by means of small tool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

**b. Labels.** The Contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the DEN Project Manager. The letters and numerals shall be not less than one inch (25 mm) in height and shall be of proportionate width. The Contractor shall also mark the correct circuit designations per the wiring diagram on the terminal marking strips, which are a part of each terminal block.

**120-3.9 Grounding.** The grounding system for the facility shall be as indicated on the contract Drawings and as specified herein. The NEC, except where otherwise indicated hereinafter, shall govern, but in no case shall the Code be violated.

**a. Equipment Grounding Conductor.**

**(1)** All metallic non-current carrying parts of electrical equipment shall be grounded with an equipment-grounding conductor whether or not shown on the drawings. The equipment-grounding conductor shall be a green insulated copper conductor unless otherwise indicated. When this conductor is not sized, or not shown on the drawings, it shall be sized in accordance with the applicable sections of the NEC and in no case shall it be smaller than #10 AWG.

**(2)** The equipment grounding conductor shall be connected to the grounded conductor in the busway. The equipment ground shall be securely bonded to the existing ground bus located behind each CCR lineup.

**b. Other Grounding System.** Any additional grounding system used for electronic equipment shall be connected directly to the exterior earth electrode system unless otherwise indicated on the drawings. Other grounding systems shall not be used in place of the equipment grounding conductor system.

**120-3.10 Constant Current Regulator.** Constant Current Regulator (CCR) shall conform to Specifications for L-829 CCRs set forth in FAA Advisory Circular 150/5345-10, latest edition. Regulators shall be individual, stand-alone units. The CCRs shall be air-cooled, dry type, ferro-resonant with internally mounted CCR/ALCMS interface unit and insulation resistance monitoring. The input power for all regulators shall be 60 Hz, 480V single phase, size as shown on the Plans. The output power shall be rated 6.6A, as shown on the Plans.

Regulators associated with taxiway centerline light circuits shall be equipped with five brightness steps, 2.8/3.2/4.1/5.2/6.6A. The regulators shall be equipped with an integral contactor for primary switching. The regulators shall have switches for remote/local function switch, local ON/OFF, and all brightness steps. The regulator must be capable of operation on 'local' control without the remote control cable connected and capable of local operation for emergency if remote switch or leads become inoperative.

Regulators shall have a direct reading, digital output RMS ammeter of +/-1 percent accuracy and a digital output RMS voltmeter of +/-1 percent accuracy. The regulator shall have automatic input voltage compensation for -5 to +10 percent variations.

Each regulator shall have integral input and output lightning protection. Output lightning arrestors shall be of the distribution type, door knob and similar type lightning arrestors are not acceptable.

Each CCR shall be provided with door safety interlocks with a maintenance bypass position. The interlock shall be wired to turn the CCR off should the door be opened.

Each CCR shall be provided with a metal drawing pocket for the instruction book. A laminated wiring diagram and troubleshooting charts shall be provided for each regulator, attached to the door interior or located in the metal drawing pocket.

Each CCR shall be provided with a metal nameplate with the following data stamped into the nameplate:

Input: \_\_\_\_\_ Volts \_\_\_\_\_ Hertz \_\_\_\_\_ Amperes

Control: \_\_\_\_\_ Volts \_\_\_\_\_ Hertz

Output: \_\_\_\_\_ kW at \_\_\_\_\_ Amperes

Output Current: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

FAA-L-829 Serial No. \_\_\_\_\_

Constant Current Regulators must be compatible with the existing ALCMS and exactly duplicate all monitoring and control functions that currently exist at the Airfield Lighting Vault.

Dry-contacts within the regulator shall be supplied for the following information:

- a. Brightness Step of CCR
- b. Loss of Input Power to CCR
- c. Incorrect Output Current
- d. Remote/Local Status
- e. Number of Lamp Failures (Accurate to one (1) lamp) (4 contacts coded in binary form 1,2,4,8)
- f. Overcurrent
- g. Open Circuit

#### h. Low VA

Regulators shall have internal distributive control equipment and monitoring devices for ALCMS interface (ADB ACE 3). The control equipment will be supplied power from the save source as the ALCMS.

**120-3.11 Testing.** This section describes the testing and demonstrations furnished by the Contractor. All items furnished and/or installed by the Contractor shall be tested and demonstrated in accordance with these specifications, the FAA advisory circulars, and the manufacturer's recommendations. All equipment and labor required for testing and demonstrations shall be furnished by the Contractor.

a. Fully test the installation by continuous operation for a period of not less than seventy-two (72) hours as a completed unit, prior to acceptance by the Owner.

b. Up to two (2) walk-throughs may be initiated by the DEN Project Manager during which the airfield lighting equipment would be required to be in operation. Additional walk-throughs may be necessary depending upon the number of discrepancies found on the previous walk-throughs.

c. The Contractor is responsible for lamp replacements and necessary maintenance of airfield items during the testing, construction and walk-through periods.

d. Test airfield lighting circuit cabling per Item L-108, Underground Power Cable for Airports.

e. Demonstrate all features and functions of all systems and instruct the Owner's personnel in the proper and safe operation of the systems.

f. The Contractor shall perform the necessary inspection and tests for some items concurrently with the installation because of subsequent inaccessibility of some components. The DEN Project Manager shall be notified by the Contractor forty-eight (48) hours in advance of any testing. There are no approved "repair" procedures for items that have failed testing other than complete replacement.

Any other corrective measures are prohibited unless approved in writing by the DEN Project Manager.

### **METHOD OF MEASUREMENT**

**109-4.1** The quantity of constant current regulators, series circuit cutouts, or other equipment to be paid for under this item shall be measured per each piece of equipment furnished and installed complete in place, ready for operation, and accepted by the DEN Project Manager. The price for this item shall include removal and disposal of existing equipment, as detailed on the plans. Also included is furnishing and installing circuit breakers, wire, conduit, bus duct connections, series circuit cutout, conduit, anchor bolts, mounting hardware, framing, and all other incidentals, materials, and labor required to complete the installation to the satisfaction of the DEN Project Manager.

### **BASIS OF PAYMENT**

**109-5.1** Payment will be made at the contract unit price for each completed and accepted vault equipment item. This price shall be full compensation for furnishing all materials and for all

preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item L-109-5.1      Install 5kW CCR with Internal ACE – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
AC 150/5345-49	Specification L-854, Radio Control Equipment;
AC 150/5345-53	Airport Lighting Equipment Certification Program

#### American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/ICEA S-85-625	Standard for Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements
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#### ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C62	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C90	Standard Specification for Loadbearing Concrete Masonry Units
ASTM D2823	Standard Specification for Asphalt Roof Coatings, Asbestos Containing
ASTM D4479	Standard Specification for Asphalt Roof Coatings – Asbestos-Free

#### Commercial Item Description (CID)

A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation) Institute of Electrical and Electronic Engineers (IEEE)
IEEE 1584	Guide for Performing Arc-Flash Hazard Calculations

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-109 AIRPORT LIGHTING VAULT EQUIPMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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Master Painter's Institute (MPI)

MPI Reference #9 Alkyd, Exterior, Gloss (MPI Gloss Level 6)

Underwriters Laboratories (UL)

UL Standard 6 Electrical Rigid Metal Conduit – Steel

UL Standard 514B Conduit, Tubing, and Cable Fittings

UL Standard 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL Standard 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

UL Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

NFPA-70E Standard for Electrical Safety in the Workplace

NFPA-780 Standard for the Installation of Lightning Protection Systems

**END OF ITEM L-109**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-109 AIRPORT LIGHTING VAULT EQUIPMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item L-110 Airport Underground Electrical Duct Banks and Conduits

### DESCRIPTION

**110-1.1** This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

### EQUIPMENT AND MATERIALS

#### **110-2.1 General.**

**a.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the DEN Project Manager.

**b.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the DEN Project Manager. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the DEN Project Manager and replaced with materials, that comply with these specifications, at the Contractor's cost.

**c.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The DEN Project Manager reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

**110-2.2 Steel conduit.** Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10-mil thick coat of asphaltum sealer or shall have a factory-bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mils of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions. In lieu of PVC coated RGS, corrosion wrap tape shall be permitted to be used where RGS is in contact with direct earth."

**110-2.3 Plastic conduit.** Plastic conduit and fittings shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10. [1] [SEP]
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

- a. Type I—Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.
- b. Type II—Schedule 40 PVC suitable for either above ground or underground use.
- c. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.
- d. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

**110-2.4 Split conduit.** Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

**110-2.5 Conduit spacers.** Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads. They shall be designed to accept No. 4 reinforcing bars installed vertically.

**110-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**110-2.7 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another DEN Project Manager approved third party certification program. Precast concrete structures shall conform to ASTM C478.

**110-2.8 Flowable backfill.** Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**110-2.9 Detectable warning tape.** Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), orange (telephone/fiber optic cabling) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

## **CONSTRUCTION METHODS**

**110-3.1 General.** The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The DEN Project Manager shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. Under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade; in other locations, the top of the duct bank or underground conduit shall be not less than 18 inches (0.5 m) below finished grade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor's expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the DEN Project Manager of any blockage in the existing ducts.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200-pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

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Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill may alternatively be used

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the DEN Project Manager. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the DEN Project Manager, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Additional duct bank supports shall be installed, as approved by the DEN Project Manager.

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion per federal, state, and local requirements is incidental to Item L-110. Unless otherwise specified, excavated materials that are deemed by the DEN Project Manager to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the DEN Project Manager and compacted per Item P-152.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no

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splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

a. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

b. Trenching, etc., in cable areas shall then proceed with approval of the DEN Project Manager, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

**110-3.2 Duct banks.** Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor shall space the conduits not less than 3 inches (75 mm) apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the DEN Project Manager for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater

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than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the DEN Project Manager shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the DEN Project Manager.

**110-3.3 Conduits without concrete encasement.** Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch (6.3 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the DEN Project Manager for review prior to use.

**110-3.4 Markers.** The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

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The Contractor shall impress the word “DUCT” or “CONDUIT” on each marker slab. Impression of letters shall be done in a manner, approved by the DEN Project Manager, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the DEN Project Manager. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the DEN Project Manager. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

**110-3.5 Backfilling for conduits.** For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the DEN Project Manager.

**110-3.6 Backfilling for duct banks.** After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 “Excavation and Embankment” except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of Item P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet (76 m) of duct bank or one work period’s construction, whichever is less.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the DEN Project Manager.

**110-3.7 Restoration.** Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include topsoiling, seeding, and mulching shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

**110-3.8 Ownership of removed cable.** All removed wire and cable shall become property of the Contractor and shall be removed off site. Removal of wire and cable shall be considered

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incidental to installation of new wire and cable. No separate payment will be made for removal of wire and cable.

### **METHOD OF MEASUREMENT**

**110-4.1** Underground conduits and duct banks shall be measured by the linear feet (meter) of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated material, and restoration, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

### **BASIS OF PAYMENT**

**110-5.1** Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material, and, for drain lines, the termination at the drainage structure. This price shall be full compensation for removal and disposal of existing duct banks and conduits as shown on the plans, furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

Payment will be made under:

Item L-110-5.1	Install 1-Way, 2-Inch PVC Duct (CLSM) – per linear foot
Item L-110-5.2	Install 1-Way, 3-Inch PVC Duct (CLSM) – per linear foot
Item L-110-5.3	Install 1-Way, 2-Inch PVC Duct (CE) – per linear foot
Item L-110-5.4	Install 1-Way, 3-Inch PVC Duct (CE) – per linear foot
Item L-110-5.5	Install 2-Way, 2-Inch PVC Ductbank (CE) – per linear foot
Item L-110-5.6	Install 2-Way, 2-1/2-Inch PVC Ductbank (CE) – per linear foot
Item L-110-5.7	Install 2-Way, 4-Inch PVC Ductbank (CE) – per linear foot
Item L-110-5.8	Install 4-Way, 4-Inch PVC Ductbank (CE) – per linear foot

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circular (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
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National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
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Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit - Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 1242	Electrical Intermediate Metal Conduit Steel
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

**END OF ITEM L-110**

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## Item L-115 Electrical Manholes and Junction Structures

### DESCRIPTION

**115-1.1** This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the DEN Project Manager. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the DEN Project Manager.

### EQUIPMENT AND MATERIALS

#### 115-2.1 General.

**a.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the DEN Project Manager.

**b.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the DEN Project Manager) and replaced with materials that comply with these specifications at the Contractor's cost.

**c.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The DEN Project Manager reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

**e.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

**115-2.2 Concrete structures.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures shall be as shown on the plans.

**115-2.3 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand 200,000 lb aircraft loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the DEN Project Manager shall be submitted by the Contractor to allow for a full evaluation by the DEN Project Manager. The DEN Project Manager shall review per the process defined in the General Provisions.

**115-2.4 Junction boxes.** Junction boxes shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a L-894 blank cover, gasket, and stainless steel hardware. All bolts, studs, nuts, lock washers, and other similar fasteners used for the light fixture assemblies must be fabricated from 316L (equivalent to EN 1.4404), 18-8, 410, or 416 stainless steel. If 18-8, 410, or 416 stainless steel is utilized it shall be passivated and be free from any discoloration. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868. All junction boxes shall be provided with both internal and external ground lugs.

**115-2.5 Mortar.** The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

**115-2.6 Concrete.** All concrete used in structures shall conform to the requirements of Item P-610, Concrete for Miscellaneous Structures.

**115-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**115-2.7 Frames and covers.** The frames shall conform to one of the following requirements:

- a. ASTM A48      Gray iron castings
- b. ASTM A47      Malleable iron castings
- c. ASTM A27      Steel castings
- d. ASTM A283, Grade D      Structural steel for grates and frames
- e. ASTM A536      Ductile iron castings
- f. ASTM A897      Austempered ductile iron castings

All castings specified shall withstand a maximum tire pressure of 250 psi and maximum load of 200,000 lbs.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word "ELECTRIC" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a "DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

**115-2.8 Ladders.** Ladders, if specified, shall be galvanized steel or as shown on the plans.

**115-2.9 Reinforcing steel.** All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

**115-2.10 Bedding/special backfill.** Bedding or special backfill shall be as shown on the plans.

**115-2.11 Flowable backfill.** Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**115-2.12 Cable trays.** Cable trays shall be of plastic. Cable trays shall be located as shown on the plans.

**115-2.13 Plastic conduit.** Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

**115-2.14 Conduit terminators.** Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

**115-2.15 Pulling-in irons.** Pulling-in irons shall be manufactured with 7/8-inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

**115-2.16 Ground rods.** Ground rods shall be one piece, copper clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet (2.4 m) long nor less than 5/8 inch (16 mm) in diameter.

## CONSTRUCTION METHODS

**115-3.1 Unclassified excavation.** It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the DEN Project Manager without additional expense to the Owner.

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The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the DEN Project Manager. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the DEN Project Manager. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the DEN Project Manager. Structures shall be placed after the DEN Project Manager has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the DEN Project Manager as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

**115-3.2 Concrete structures.** Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the DEN Project Manager before the concrete is placed.

**115-3.3 Precast unit installations.** Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

**115-3.4 Placement and treatment of castings, frames and fittings.** All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the DEN Project Manager and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is

granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the DEN Project Manager and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor's expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

**115-3.5 Installation of ladders.** Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

**115-3.6 Removal of sheeting and bracing.** In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The DEN Project Manager may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

**115-3.7 Backfilling.** After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the DEN Project Manager.

Backfill shall not be placed against any structure until approval is given by the DEN Project Manager. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the DEN Project Manager establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the DEN Project Manager may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

**115-3.8 Connection of duct banks.** To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

**115-3.9 Grounding.** A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm)

diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtailed shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

**115-3.10 Cleanup and repair.** After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer's recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

**115-3.11 Restoration.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

**115-3.12 Inspection.** Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

**115-3.13 Manhole elevation adjustments.** The Contractor shall adjust the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor shall be responsible for determining the exact height adjustment required to raise or lower the top of each manhole to the new elevations. The existing top elevation of each manhole to be adjusted shall be determined in the field and subtracted/added from the proposed top elevation.

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The Contractor shall remove/extend the existing top section or ring and cover on the manhole structure or manhole access. The Contractor shall install precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or shall cut the existing manhole walls to shorten the existing structure, as required by final grades. The Contractor shall reinstall the manhole top section or ring and cover on top and check the new top elevation.

The Contractor shall construct a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab shall conform to the dimensions shown on the plans.

**115-3.14 Duct extension to existing ducts.** Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

### **METHOD OF MEASUREMENT**

**115-4.1** Electrical manholes and junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering; sheeting and bracing; all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections; and ground rod testing

**115-4.2 Manhole elevation adjustments** shall be measured by the completed unit installed, in place, completed, and accepted. Separate measurement shall not be made for the various types and sizes.

### **BASIS OF PAYMENT**

**115-5.1** The accepted quantity of electrical manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

**115-5.2** Payment shall be made at the contract unit price for manhole elevation adjustments. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary, including but not limited to, spacers, concrete, rebar, dewatering, excavating, backfill, topsoil, sodding and pavement restoration, where required, to complete this item as shown in the plans and to the satisfaction of the DEN Project Manager.

Payment will be made under:

Item L-115-5.1      Install Electrical Handhole – per each

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

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**American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)**

ANSI/IEEE STD 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

**Advisory Circular (AC)**

AC 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits

AC 150/5345-26 Specification for L-823 Plug and Receptacle, Cable Connectors

AC 150/5345-42 Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories

AC 150/5340-30 Design and Installation Details for Airport Visual Aids

AC 150/5345-53 Airport Lighting Equipment Certification Program

**Commercial Item Description (CID)**

A-A 59544 Cable and Wire, Electrical (Power, Fixed Installation)

**ASTM International (ASTM)**

ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application

ASTM A47 Standard Specification for Ferritic Malleable Iron Castings

ASTM A48 Standard Specification for Gray Iron Castings

ASTM A123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products

ASTM A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A536 Standard Specification for Ductile Iron Castings

ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A897 Standard Specification for Austempered Ductile Iron Castings

ASTM C144 Standard Specification for Aggregate for Masonry Mortar

ASTM C150 Standard Specification for Portland Cement

ASTM C206 Standard Specification for Finishing Hydrated Lime

**FAA Engineering Brief (EB)**

EB #83 In Pavement Light Fixture Bolts

**Mil Spec**

MIL-P-21035 Paint High Zinc Dust Content, Galvanizing Repair

**National Fire Protection Association (NFPA)**

NFPA-70 National Electrical Code (NEC)

**END OF ITEM L-115**

## Item L-125 Installation of Airport Lighting Systems

### DESCRIPTION

**125-1.1** This item shall consist of airport lighting systems furnished and installed in accordance with this specification, the referenced specifications, and the applicable advisory circulars (ACs). The systems shall be installed at the locations and in accordance with the dimensions, design, and details shown in the plans. This item shall include the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the DEN Project Manager.

### EQUIPMENT AND MATERIALS

#### 125-2.1 General.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified under the Airport Lighting Equipment Certification Program in accordance with AC 150/5345-53, current version. FAA certified airfield lighting shall be compatible with each other to perform in compliance with FAA criteria and the intended operation. If the Contractor provides equipment that does not perform as intended because of incompatibility with the system, the Contractor assumes all costs to correct the system for to operate properly.

**b.** Manufacturer's certifications shall not relieve the Contractor of their responsibility to provide materials in accordance with these specifications and acceptable to the DEN Project Manager. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the DEN Project Manager and replaced with materials, which do comply with these specifications, at the sole cost of the Contractor.

**c.** All materials and equipment used shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Clearly mark each copy to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be clearly made with arrows or circles (highlighting is not acceptable). The Contractor shall be responsible for delays in the project accruing directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be submitted in electronic PDF format, tabbed by specification section. The DEN Project Manager reserves the right to reject any or all equipment, materials or procedures, which, in the DEN Project Manager's opinion, does not meet the system design and the standards and codes, specified herein.

**e.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. All LED

light fixtures must be warranted by the manufacturer for a minimum of 4 years after date of installation inclusive of all electronics.

## EQUIPMENT AND MATERIALS

**125-2.2 Conduit/Duct.** Conduit shall conform to Specification Item L-110 Airport Underground Electrical Duct Banks and Conduits.

**125-2.3 Cable and Counterpoise.** Cable and Counterpoise shall conform to Item L-108 Underground Power Cable for Airports.

**125-2.4 Tape.** Rubber and plastic electrical tapes shall be Scotch Electrical Tape Numbers 23 and 88 respectively, as manufactured by 3M Company or an approved equal.

**125-2.5 Cable Connections.** Cable Connections shall conform to Item L-108 Installation of Underground Cable for Airports.

**125-2.6 Retroreflective Markers.** Not required.

**125-2.7 Runway and Taxiway Lights.** Runway and taxiway lights shall conform to the requirements of AC 150/5345-46. Lamps shall be of size and type indicated, or as required by fixture manufacturer for each lighting fixture required under this contract. Filters shall be of colors conforming to the specification for the light concerned or to the standard referenced.

### Lights

Type	Class	Mode	Style	Base	Filter	Transformer	Notes
L-852C(L)	2	1	3	L-868B	Green	Per Mfg	Heater Kit
L-852D(L)	2	1	3	L-868B	Yellow	Per Mfg	Heater Kit
L-852K(L)	2	1	3	L-868B	Green	Per Mfg	Heater Kit
L-852T(L)	2	1	3	L-868B	Blue	Per Mfg	Heater Kit
L-861T(L)	N/A	1	N/A	L-867B	Blue	Per Mfg	Heater Kit

**125-2.8 Runway and Taxiway Signs.** Runway and Taxiway Guidance Signs should conform to the requirements of AC 150/5345-44. Signs shall be equipped with a weatherproof on/off toggle switch. The switch shall be located on the end-panel of the sign adjacent to the power leg. The switch shall be protected from driving rain and icing. The switch shall de-energize the sign so that maintenance work can be performed safely.

In addition, ID tags shall be installed on all new signs. ID tags shall consist of 2" high yellow text on a black background. Tags shall be constructed of UV resistant phenolic material and shall be attached to the side of the sign closest to the taxiway pavement using stainless steel screws or pop rivets. Circuit name and sign identifier shall be engraved on tags as shown on the Plans.

### Signs

Type	Size	Style	Class	Mode	Notes
L-858Y(L)	3	5	2	2	LED
L-858L(L)	3	5	2	2	LED

**125-2.9 Runway End Identifier Light (REIL).** Not required.

**125-2.10 Precision Approach Path Indicator (PAPI).** Not required.

**125-2.11 Circuit Selector Cabinet.** Not required.

**125-2.12 Light Base and Transformer Housings.** Light Base and Transformer Housings should conform to the requirements of AC 150/5345-42. Light bases shall be Type L-867 or L-868, Class 1A, Size B shall be provided as indicated or as required to accommodate the fixture or device installed thereon. Base plates, cover plates, and adapter plates shall be provided to accommodate various sizes of fixtures.

**125-2.13 Isolation Transformers.** Isolation Transformers shall be Type L-830, size as required for each installation. Transformer shall conform to AC 150/5345-47.

**125-2.14 Cementitious Grout.** For use in the installation of ID markers. The cementitious grout shall be non-shrink, non-metallic and contain no chloride. When mixed to a fluid state, the typical compressive strength shall reach 5,800 psi in 28 days, and positive expansion. The grout shall meet the requirements of ASTM C1107 and ASTM C827.

**125-2.15 Silicone Grease.** Designed for application on rubber O-rings installed between flange rings and light fixtures. The grease shall consist of a composition of polydimethylsiloxane and fumed silica. The grease shall be moisture resistant, prevent corrosion/oxidation, and have a service temperature range of -40°F to +400°F.

**125-2.16 Base Can Sealant.** For application between the top of a load bearing base can and spacer rings and/or spacer rings and bottom of flange ring with pavement dam. The 100% silicone sealant shall be non-shrink.

## INSTALLATION

**125-3.1 Installation.** The Contractor shall furnish, install, connect and test all equipment, accessories, conduit, cables, wires, buses, grounds and support items necessary to ensure a complete and operable airport lighting system as specified here and shown in the plans.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and state and local code agencies having jurisdiction.

The Contractor shall install the specified equipment in accordance with the applicable advisory circulars and the details shown on the plans.

**125-3.2 Testing.** All lights shall be fully tested by continuous operation for not less than 24 hours as a completed system prior to acceptance. The test shall include operating the constant current regulator in each step not less than 10 times at the beginning and end of the 24-hour test. The fixtures shall illuminate properly during each portion of the test.

**125-3.3 Shipping and Storage.** Equipment shall be shipped in suitable packing material to prevent damage during shipping. Store and maintain equipment and materials in areas

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protected from weather and physical damage. Any equipment and materials, in the opinion of the DEN Project Manager, damaged during construction or storage shall be replaced by the Contractor at no additional cost to the owner. Painted or galvanized surfaces that are damaged shall be repaired in accordance with the manufacturer's recommendations.

**125-3.4 Elevated and In-pavement Lights.** Water, debris, and other foreign substances shall be removed prior to installing fixture base and light.

A jig or holding device shall be used when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Light fixtures shall be oriented with the light beams parallel to the runway or taxiway centerline and facing in the required direction. The outermost edge of fixture shall be level with the surrounding pavement. Surplus sealant or flexible embedding material shall be removed. The holding device shall remain in place until sealant has reached its initial set.

### **METHOD OF MEASUREMENT**

**125-4.1** Taxiway lights will be measured by the number of each type installed as completed units in place, ready for operation, and accepted by the DEN Project Manager. Guidance signs will be measured by the number of each type and size installed as completed units, in place, ready for operation, and accepted by the DEN Project Manager.

### **BASIS OF PAYMENT**

**125-5.1** Payment will be made at the Contract unit price for each complete taxiway light or guidance sign, installed by the Contractor and accepted by the DEN Project Manager. This payment will be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

Payment will be made under:

Item L-125-5.1	Install L-852C(L) Bidirectional Taxiway Centerline Light – per each
Item L-125-5.2	Install L-852D(L) Unidirectional Taxiway Centerline Light – per each
Item L-125-5.3	Install L-852K(L) Bidirectional Taxiway Centerline Light – per each
Item L-125-5.4	Install L-852T(L) Taxiway Edge Light – per each
Item L-125-5.5	Install L-861T(L) Taxiway Edge Light – per each
Item L-125-5.6	Install L-868B Cover Plate – per each
Item L-125-5.7	Install L-868B Base Can (22" Deep) in Concrete Pavement – per each
Item L-125-5.8	Install L-867B Base Can (Adjustable Depth) in Asphalt Pavement – per each
Item L-125-5.9	Install L-858(L) Guidance Sign, 3 Module – per each
Item L-125-5.10	Install L-858(L) Guidance Sign, 4 Module – per each
Item L-125-5.11	Install L-858 Guidance Sign Panels – per each
Item L-125-5.12	Install Guidance Sign Foundation, 3 Module – per each

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Item L-125-5.13	Install Guidance Sign Foundation, 4 Module – per each
Item L-125-5.14	Cover Taxiway Edge Light – per each
Item L-125-5.15	Install Shorting Plug – per each
Item L-125-5.16	Cover Guidance Sign – per each
Item L-125-5.17	Instll L-858(L) Guidance Sign, 2 Module – per each
Item L-125-5.18	Install Guidance Sign Foundation, 2+3 Module – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### Advisory Circulars (AC)

AC 150/5340-18	Standards for Airport Sign Systems
AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems
AC 150/5345-39	Specification for L-853, Runway and Taxiway Retroreflective Markers
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5345-44	Specification for Runway and Taxiway Signs
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures
AC 150/5345-47	Specification for Series to Series Isolation Transformers for Airport Lighting Systems
AC 150/5345-51	Specification for Discharge-Type Flashing Light Equipment
AC 150/5345-53	Airport Lighting Equipment Certification Program

#### Engineering Brief (EB)

EB No. 67	Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures
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**END OF ITEM L-125**

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## Item L-140 Field Photometric Testing

### DESCRIPTION

**140-1.1 General.** Photometric testing of airfield lighting systems shall be performed by a firm with demonstrated capability for the field measurement of the photometric performance of airfield lighting fixtures. The firm shall have experience in evaluating the test results against FAA standards and manufacturers' performance criteria. The firm shall demonstrate its capability by having performed similar work successfully at no less than ten (10) international air carrier airports in the past five (5) years. Suggested contacts for this service shall be as follows or approved equal.

Lean Engineering  
17752 Mitchell N, Suite C  
Irvine, CA 92614  
Phone: (949) 502-8687  
Email: dlean@LeanCorp.com

Navaid Lighting Associates, Inc.  
141 Autumn Glenn Road  
Saltillo, MS 38866  
Phone: (662) 869-8655  
Fax: (662) 869-0065  
Cell: (662) 322-6418  
Email: david@navaidlighting.com

Photometric testing shall be performed at night between one hour after sunset and one hour before sunrise, with minimum interference to airport operations. Within 24 hours before starting the test, the Contractor shall clean all the light fixtures within the testing schedule to assure that the system is ready for photometric testing. The Contractor shall also verify calibration of constant current regulator output using a true root-mean-squared (RMS) ammeter prior to the testing.

A list of equipment to be used for the photometric testing shall be submitted. In addition, a record of experience on similar projects with references for future contact shall be submitted.

**140-1.2 Testing Requirements.** The testing shall be performed on all taxiway (new or reinstalled) centerline light fixtures installed as part of this project. No testing is required for elevated taxiway edge lights.

The photometric test equipment shall consist of an array of sensors capable of taking simultaneous light readings as the equipment moves away from a light source. There shall be no loss of accuracy at speeds allowed by the Airport.

The system shall be capable of accurately tracking the position of each sensor relative to the specified main beam area of each fixture type being measured.

The system shall be capable of automatically calculating the average intensity (in candela) in the main beam and 10 percent beam areas to estimate the vertical and horizontal beam alignment (in degrees) by identifying the brightest part of the light beam being measured.

The system shall log the data while testing commences, display the results and identify locations where the minimum average main beam intensities are below the levels listed in FAA AC 150/5345-46 and/or the main beam is mis-aligned either vertically or horizontally.

The system shall log the GPS coordinates for each light fixture while each test is being run.

A print out or electronic copy of the test readings will be made available periodically during the progress of the testing.

The measurements shall be compared to FAA standards as presented in FAA AC 150/5345-46. The calculated averages shall be not less than the minimum average intensities specified in the Advisory Circular in order for the fixture to be considered acceptable.

If any of the calculated average readings is below the specified minimum average intensity, or if any individual reading is below fifty percent (50%) of the specified minimum average intensity, additional sets of readings shall be taken as required to identify the problem(s) with the fixture in question.

**140-1.3 Test Reports.** Initial reports will be submitted periodically during the progress of the work so that corrective measures may be taken as may be required. If the corrective measures are promptly made, the fixtures involved will be reevaluated during the scheduled period of field testing to assure that proper performance has been achieved.

The final test results shall be documented in a Final Report, with six (6) copies submitted to the Airport. The Final Report shall present an evaluation of each fixture tested. For those fixtures that do not meet the performance requirements, the Final Report shall include proposed corrective measures, such as cleaning or replacement of lenses, re-aiming of fixture including resetting of base can, grinding of pavement, repair/replacement of fixture, or any combination of issues. Allowance of the light output to 70% of the minimum average intensity as recommended by AC 150/5340-26, Maintenance of Airport Visual Aid Facilities, will not be accepted for new fixture installations. The final test results for existing light fixtures will indicate which fixtures do not meet the performance requirements in addition to the light output level being below 70% of the minimum average intensity listed in AC 150/5345-46.

The Final Report shall include the following:

- a. Performance Bar Chart for each runway or taxiway system, such as Runway 34R centerline or Runway 16L touch down zone. This provides a visual indication of overall performance for the service and identifies the relative position of sub-standard fixtures.
- b. Colour Iso-candela diagrams of fixture light output for representative fixtures that have failed due to low light output or mis-alignment.

c. Photometric test data tabulated with the following information:

Fixture Number	First and last fixture in a series as shown on the Plans
Light Direction	Direction/orientation of light beam
Max CD	Maximum candela output in a point along the main beam
Avg. CD	Average candela on fixture being tested
Lens Color	Color of lens on fixture being tested

d. Max Sensor Reading Sensor number (on the sensor bar) that provides the maximum reading.

**140-1.4 Spares.** As part of this work the contractor shall have on-hand a minimum of 10 percent of additional light fixtures of every type to replace deficient fixtures as a result of the photometrics. This material shall be on-hand during the testing so that the light fixtures can be replaced during the test, and the fixtures retested at once. Any deficient fixtures shall be sent to the manufacturer for replacement and replenished back to the airport. The warranty shall commence after the photometric testing is complete and all fixtures passed. Unused fixtures shall become the property of the airport.

**140-1.5 Corrective Action.** The Contractor shall be responsible for correcting any deficient condition identified as a result of the photometric testing. If retesting of corrected conditions can be completed within the originally scheduled field test period, then retesting shall be performed to verify that any deficient condition has been successfully corrected. If retesting is required after the scheduled photometric testing period, additional costs to test corrected fixtures shall be borne by the Contractor.

### METHOD OF MEASUREMENT

**140-2.1** Taxiway light photometric testing shall be measured as lump sum for all taxiway semi-flush lights verified as correct and ready for operation, with documentation submitted to and accepted by the DEN Project Manager. These costs shall include any new lights required to meet photometric requirements and any retesting of lights as required.

### BASIS OF PAYMENT

**140-3.1** Payment will be made at the contract unit price per lump sum for completed and approved testing of lights. This price shall include all labor, equipment, tools, and materials necessary to complete the work specified, including retesting of new fixtures found to be deficient in the initial testing and corrected by the Contractor. Any photometric retesting shall be paid by the Contractor and is incidental to the installation of the lighting systems.

Payment shall be made as follows:

Item L-140-3.1	Photometric Testing – per lump sum
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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-140 FIELD PHOTOMETRIC TESTING**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**END OF ITEM L-140**

## **Item 13410A Airfield Lighting Control and Monitoring System Modifications**

### **DESCRIPTION**

#### **13410A-1.1 Project Scope.**

This specification details the scope for the manufacturer of the ALCMS, ADB-Safegate:

- a.** Provide new functionality, preset table, graphic changes for the new CCR.
- b.** Verify wiring and operation of the new CCRs. Provide wiring diagrams and parts list to all bidding contractors.
- c.** Modify ALCMS to accommodate reconfiguration of circuits as shown on drawings. Reconfigure the ALCMS and presets accordingly and submit new ALCMS Demonstration CD accordingly.
- d.** Additionally CCRs shall require new control wire to/from each CCR to the ALCMS computer cabinet.
- e.** Provide the following equipment:
  - (1) 20 kW CCRs w/ Internal Ace Unit
  - (2) Control wire for new CCRs as required.
- f.** All bidding contractors shall get the same price.
- g.** The work shall include all supervision, labor, software, programming, materials, tools, equipment, testing of the installation, manual updates, and all incidentals necessary to provide a fully functional and complete system to the satisfaction of the DEN Project Manager.
- h.** Maintain a fully functional and operational airport lighting control system throughout the modification and testing of the affected system components. Coordinate construction with the DEN Project Manager to avoid conflicts with airport operational requirements and to schedule required system outages.
- i.** Provide a 1 year maintenance warranty agreement which shall include the furnishing of key spare parts along with technical support on a 24 hour/ 7 day week/ 365 day year both remote and on site.

#### **13410A-1.2 Submittal.**

- a.** Equipment and software submittals shall meet the requirements listed in Item L-100, Lighting and Electrical Work. The Supplier shall submit the complete dimensional and performance characteristics, system block diagram, wiring schematic diagrams and installation and operation instructions. The block diagram shall reflect the total integration of all new digital

and analog devices into the existing system. The diagram shall reference all interconnection cabling requirements for digital components of the system including any data communications links.

**b.** All significant equipment to be supplied shall be listed, followed by descriptive data sheets. The equipment list shall include each component name, supplier, model number, a description of the operation, quantity supplied and any special setup, operation and maintenance characteristics.

**c.** Software submittals shall provide a complete description of the system on a functional level.

**d.** Submittals of graphic displays shall include color pictorial representations of all runway and taxiway operations above 1200' RVR, between 1200' and 500' RVR, and below 500' RVR, including SMGCS operations affected by this project.

**13410A-1.3 Operation and Maintenance Manuals.** The supplier shall provide revision pages for eight existing operation and maintenance manuals. The manual revisions shall be easy-to-understand and contain detailed instructions and well-diagrammed procedures for operations and systems maintenance. The supplier shall also upload accurate, legible system drawings in document libraries in all ALCMS maintenance computers.

**13410A-1.4 Warranty.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of twenty-four (24) months or the manufacturer's standard guarantee period whichever is greater, from final acceptance by the DEN Project Manager. Any defective materials and/or equipment shall be repaired or replaced, at the DEN Project Manager's discretion, with no additional cost to the Owner.

**13410A-1.5 Testing.**

**a. General:**

(1) All elements of the ALCMS system affected by work associated with this project shall be tested to demonstrate that the total system satisfies all of the functional requirements of this Specification.

(2) As a minimum, the testing shall include the following:

**(a)** Software Implementation Tests (SIT).

**(b)** Operational Acceptance Tests (OAT).

**(c)** Functional Acceptance Tests (FAT).

(3) Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the systems or subsystems producing the correct result (effect), the specific test requirement will have been satisfied.

(4) All tests shall be conducted in accordance with, and documented on, prior Owner-approved procedures, forms, and checklists. Each specific test to be performed shall be

described and a space provided after it for signoff by the appropriate party after its satisfactory completion.

- (5) Copies of these signoff test procedures, forms, and checklists will constitute the required test documentation.
- (6) Provide all special testing materials and equipment. Perform tests using actual system variables, equipment, and data.
- (7) Coordinate all testing with the Owner.
- (8) The Owner will actively participate in many of the tests. The Owner reserves the right to test or retest any and all specified functions whether or not explicitly stated in the prior-approved Test Procedures.
- (9) The Owner's decision shall be final regarding the acceptability and completeness of all testing.

**b. Software Implementation Tests (SIT):**

- (1) The new software shall be installed on one of the existing ALCMS for testing and to demonstrate that the proposed system components will function through the reconfigured software.
- (2) Tests shall demonstrate all newly installed or reinstalled hardware and software components function to the satisfaction of the Owner. As a minimum the tests shall include the following from AC 150/5345-56, Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS), latest edition:
  - (a) 10.6.1 Communication Link Test
  - (b) 10.6.3 Tower Remote Control Test
  - (c) 10.6.4 Requesting and Granting Control
  - (d) 10.6.5 Preset Failsafe System Test
  - (e) 10.9.3 Initiating a Low Visibility Test
  - (f) Operational state of the remote Circuit Selector Switch test.

**c. Operational Acceptance Tests (OAT):**

- (1) At the completion of the SIT, the system shall be made available to the Owner's personnel for hands-on operational testing. The system shall be completely usable and available for the OAT.
- (2) The OAT will run for a period of 2 days. Coordinate all tests and provide assistance for any simulations needed with the Owner. The supplier shall be on site for the duration of the tests. The OAT shall be performed for both the primary and secondary ALCMS.

(3) At the end of the OAT, the Owner, and Contractor shall coordinate and address any discrepancies found during the OAT.

(4) All discrepancies shall be taken care of prior to the start of the FAT.

**d. Functional Acceptance Tests (FAT):**

(1) Once the system has completed the OAT, a witnessed Functional Acceptance Test shall be performed on the complete ALCMS to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph and site-by-site basis.

(2) Updated versions of the documentation shall be made available to the Owner at the jobsite both before and during the tests. In addition, one copy of an O&M Manual shall be made available to the Owner at the jobsite both before and during testing.

(3) The daily schedule called for under paragraph SIT shall also be followed during the FAT.

**13410A-1.6 Onsite Services.**

**a. General:**

(1) Provide experienced personnel and management onsite to coordinate and effect, for modifications to the Airfield Lighting Control and Monitoring System:

- (a) Installation, termination, and adjustment.
- (b) All onsite testing.
- (c) Startup assistance.

**b. Onsite Supervision:**

(1) Provide onsite, an experienced resident engineering manager to supervise and coordinate all of the onsite Airfield Lighting Control and Monitoring System activities. This resident engineering manager shall be onsite during the total period required to effect all of the required onsite activities relating to the Airfield Lighting Control and Monitoring System modification.

**c.** Attend planning meetings (2 of them) as required.

**d. Testing Team:**

(1) Provide, onsite, a team of experienced engineering and technician personnel during the total period required to:

(a) Thoroughly check the installation, termination, and adjustment of all of the Subsystems and their components affected by this project.

(b) Perform and complete all onsite tests.

(c) Provide assistance to the Owner for a period of one calendar week after interim and final acceptance inspections.

**13410A-1.7 Project Conditions.**

a. This project is located on an active airport and work is subject to security and other restrictions.

b. The airport will be operational during construction and requires coordination and prior approval from the resident engineer for any planned power and systems outages. All work inside the airport security fence shall be coordinated with the DEN Project Manager.

c. The existing airport lighting control system shall remain operational during construction and testing of the system modifications. The existing control system configuration shall remain operational until the DEN Project Manager accepts the new system modifications.

**13410A-1.8 Hardware for Procurement.**

a. CCRs

b. Any modifications or additional hardware required to the computer rack to accommodate the new CCRs.

**13410A-1.9 Software Procurement**

a. Modifications to airfield graphics and demonstration CD.

**CONSTRUCTION REQUIREMENTS**

**13410A-2.1** In the event that a communication or software adjustment or defective equipment requires repair or replacement, testing may be suspended or continued at the sole discretion of the DEN Project Manager. Prior tests shall be verified to still meet the project requirements before continuing if testing is suspended.

**13410A-2.2** If the need for further adjustments of any kind becomes evident during inspection or demonstration, the supplier shall continue work until the installation operates properly.

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**ITEM 13410A – AIRFIELD LIGHTING CONTROL AND**  
**MONITORING SYSTEM MODIFICATIONS**

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### **METHOD OF MEASUREMENT**

**13410A-3.1** ALCMS modification shall be measured for payment as lump sum for providing services, material and coordinating the update of the existing ALCMS computer to reflect changes associated with this project, testing, coordination, site support, as-built, and all other appurtenances and accessories required for a fully functional system in place, ready for operation and accepted by the DEN Project Manager as described in drawings. This bid item shall also include furnishing any material such as wire, cable, and parts required to add the new CCRs to the existing ALCMS. Bid item shall be paid once upon completion of all commissioning and testing is performed and accepted by the DEN Project Manager. This bid item shall include all taxes, overhead, and profit.

**13410A-3.2** Furnishing constant current regulators shall be bid under a separate bid item under L-109.

### **BASIS OF PAYMENT**

Payment will be made at the lump sum unit price for ALCMS modifications.

Payment will be made under:

Item 13410A-5.1      Airfield Lighting Control System Modifications – per lump sum

**END OF ITEM 13410A**

**SECTION 260400 - BASIC ELECTRICAL REQUIREMENTS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.
- B. Where a panel is installed, at least 25% of panel capacity, accounting for serving panel capacity, shall remain as spare capacity after project completion.
- C. Related Sections:
  - 1. Basic Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 General Requirements, and Divisions 27 and 28.
  - 2. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 26.
  - 3. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the Contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.
  - 4. Temporary Power: See Division 1 for construction power constraints.
- D. REFERENCE STANDARDS
- E. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- F. Latest editions of the following:
  - 1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Department).
  - 2. International Fire Code (as amended by the Denver Fire Department).
  - 3. International Building Code (as adopted and amended by the Denver Building Department).
  - 4. International Energy Conservation Code (as adopted and amended by the

- Denver Building Department).
5. ANSI/IEEE C2 - National Electrical Safety Code.
  6. OSHA - Occupational Safety and Health Administration, as Amended
  7. Underwriter's Laboratory (UL).
  8. National Fire Protection Association (NFPA).
  9. Other references as listed elsewhere in these specifications.
  10. IEEE Standard 519- Recommended Practices and Requirement for Harmonic Control in Electrical Power Systems.

### 1.3 DEFINITIONS

- A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
- B. "Install": To erect, mount and connect complete with related accessories.
- C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Wiring": Raceway, fittings, wire, boxes and related items.
- F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
- G. "Or Equal. Or Approved Equal": Refers to products that, in the opinion of the DEN Project Manager, are similar in all respect to products specified by proprietary brand name.
- H. "Exposed": Not installed underground or "concealed" as defined above.
- I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.
- J. "Similar" or "Equal": Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
- K. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to DEN Project Manager.
- L. "Related Work" includes all "Work" required for a complete working system.
- M. "Equipment": A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.
- N. "Busbar": A rigid metallic conductor, lug or bar used to make a common connection

between more than one circuit. (Includes all termination assemblies.)

- O. "Shall": Mandatory requirements of this specification are characterized by the use of the word "shall".
- P. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this Project.

#### 1.4 WORK SEQUENCE

- A. Construct Work in sequence under provisions of Division 1 where applicable.

#### 1.5 DRAWINGS AND SPECIFICATIONS

- A. The Drawings indicate the general arrangement of circuits, outlets, panelboards and other work. Information shown on the Drawings is schematic; however, re-circuiting will not be permitted without specific acceptance. In cases of conflict between specifications and drawings, the specification shall have precedence. Data presented on the drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all of the Contract Documents and adjust all work to conform to all conditions shown therein.
- B. Prior to submitting a bid, a site visit is required to ascertain all conditions affecting the proposed installation and to adjust all work accordingly. Costs for providing for these adjustments, including response to site constraints, shall be itemized and listed in the bid proposal.
- C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the DEN Project Manager in writing 72 hours before the date of bid opening. In the event such discrepancies exist, and the DEN Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the DEN Project Manager.

#### 1.6 COORDINATION

- A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.
- B. Any electrical work penetrating concrete walls or floors shall require saw cutting and/or core drilling and shall require approval by the DEN Project Manager. The Contractor shall perform all necessary imaging (x-rays, etc.) as specified, and submit shop drawings of any saw cutting or core drilling to the DEN Project Manager prior to performing the Work. Refer to Section 017330 "Cutting and Patching" for additional

requirements.

- C. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

#### 1.7 COORDINATION DRAWINGS

- A. Where the Contractor modifies the design, through selection of equipment differing from that shown, coordination drawings shall be provided by the Contractor in accordance with Division 1 to a scale of 1/4"=1'0" or larger for equipment rooms, details, congested areas and sections; other plans at a scale of 1/8"=1'0". These drawings are to detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components.
- B. Coordination drawings shall be in accordance with current DEN standards for format, and as outlined in Division 1.
- C. The Contractor shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Indicate the proposed locations of raceway systems, equipment, and materials. Include the following:
    - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    - b. Exterior wall and foundation penetrations.
    - c. Fire-rated wall and floor penetrations.
    - d. Equipment connections and support details.
    - e. Sizes and location of required concrete pads and bases.
    - f. Support details.
  - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
  - 3. Floor plans, elevations, and appropriate details are required to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

#### 1.8 SUBMITTALS

- A. Refer to Section 013300 "Submittal Procedures".
- B. Submit shop drawings, coordination drawings and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.

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- C. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with Contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
- D. Clearly mark each shop drawing as follows for purposes of identification:
1. Shop Drawing.
  2. Equipment Identification Used on Contract Drawings.
  3. Date.
  4. Name of Project.
  5. Branch of Work.
  6. Project Manager's Name.
  7. Contractor's Name.
- E. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the Contract document schedules. Contractor agrees that submittals processed by the DEN Project Manager are not change orders; that the purpose of submittals is to demonstrate to the DEN Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material the Contractor intends to furnish and install and by detailing the installation methods the Contractor intends to use.
- F. Contractor shall be responsible for dimensions (which the Contractor shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of the Contractor's Work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.
- G. Maintain one copy of accepted shop drawings at the Project field office until completion of the Project, and make this copy available, upon request, to representatives of the DEN Project Manager and Owner.
- H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action by the DEN Project Manager accepting their use.
- I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this Project.
- 1.9 RECORD DOCUMENTS
- A. Maintain a Contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of

drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the DEN Project Manager at all times. Upon completion of the Contract, this set of record drawings shall be delivered to the DEN Project Manager. Follow current DEN BIM standards, to be furnished to the successful bidder as well as the project-specific BIM execution plan. Record documents to be provided by the Contractor shall clearly and accurately show the following:

1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

#### 1.10 REGULATORY REQUIREMENTS

- A. Obtain all permits, plan review, and inspections from authority having jurisdiction.
- B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than the drawings and specifications.

#### 1.11 ENVIRONMENTAL CONDITIONS

- A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:
  1. Location: Indoors/Outdoors.
  2. Altitude: 5,500 feet above sea level.
  3. Temperature range: -30°F to 120°F.

#### 1.12 WARRANTY

- A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two (2) years, or any longer period specifically noted elsewhere in these specifications, from date of substantial completion.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS AND EQUIPMENT

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- A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.
- B. All equipment and materials installed shall be new, unless otherwise specified.
- C. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the DEN Project Manager or Owner and at no additional cost to the Owner.
- D. All electrical "equipment" and assemblies shall be acceptable for installation only if labeled and listed by a nationally recognized testing laboratory, such as UL or an equivalent.
- E. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

## 2.2 STORAGE AND PROTECTION

- A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.
- C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

## 2.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only:
  - 1. Any product meeting those standards.
- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions:
  - 1. Submit a request for substitution for any manufacturer not specifically named with supporting documentation for approval by DEN Project Manager.

## 2.4 PRODUCTS LIST

- A. Within fifteen (15) days after date of Notice to Proceed, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

**2.5 SUBSTITUTIONS**

- A. Refer to Division 1 General Requirements, Section 012510 "Substitutions".

**PART 3 - EXECUTION****3.1 WORKMANSHIP**

- A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of Work, as determined by the DEN Project Manager, are not acceptable and shall be corrected at the contractors cost.
- B. Contractor shall include no more than one apprentice per Journeyman Electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.
- C. Any changes or deviations from the drawings and specifications must be accepted in writing by the DEN Project Manager. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- D. Upon completion of Work, all equipment and materials shall be installed complete, thoroughly tested, checked, correctly adjusted, and left ready for intended use or operation. All Work shall be thoroughly cleaned and all residues shall be removed from surfaces. Exterior surfaces of all material and equipment shall be left in a perfect, unblemished condition.
- E. Contractor shall provide a complete installation, including all required labor, material, cartage, testing, insurance, permits, and taxes.

**3.2 CHASES, OPENINGS, CUTTING AND PATCHING**

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the DEN Project Manager. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and shall be pre-approved by the DEN Project Manager.
- B. All penetrations required through completed concrete construction shall be core drilled at minimum size required. All penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete.

**3.3 ELECTRICAL INSTALLATIONS**

- A. Coordinate electrical systems, equipment, and material installation with other building components. If the Contractor furnishes equipment of a different size, the Contractor shall furnish and install the proper fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner, and as deemed acceptable by the DEN Project Manager.

**3.4 PROGRESS OF WORK**

- A. Coordinate the progress of electrical work to conform to the progress of the Work of the other trades. Complete the entire installation as soon as the condition of the sites will permit. Any cost resulting from defective or ill-timed work performed under Division 26 shall be borne by the Contractor.

**3.5 ELECTRICAL COMPLETION**

- A. Training of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.
  - 1. Instruction shall be given when the particular system is complete, shall be of the number of hours indicated, and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.
- B. Operating and Maintenance Manuals and Parts Lists: Deliver three (3) complete operating & maintenance manuals and parts lists in three-ring binders to the Owner at the time of the above required training. The information shall be provided on the manufacturer's original data sheets. Fully explain the contents of the manuals as part of required training and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.
  - 1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.
- C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications for all applicable equipment furnished and installed as part of this Contract. Submit three (3) copies of test reports to the DEN Project Manager for the DEN Project Manager's approval.
- D. Clean Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Clean all electrical equipment, such as switchboards, panel boards,

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luminaries etc. of construction dirt, dust, etc. and touch-up or repaint all scratches, blemishes, rust spots etc. to its original condition. Any costs to the Owner for cleanup of the site will be charged against the Contractor.

- E. Acceptance Demonstration: Upon completion of the Work, at a time to be designated by the DEN Project Manager, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided or modified under this Contract.
- F. Final Acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment, as approved by DEN Project Manager.

**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. Basic Electrical Requirements shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 260400**

## **SECTION 260510 - TESTING, ACCEPTANCES AND CERTIFICATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY OF REQUIREMENTS**

- A. The Contractor shall provide the necessary field-testing and startup services for all electrical and mechanical equipment except as noted otherwise. The field-testing and startup services shall be in accordance with each equipment manufacturer's written recommendations for field-testing proving they meet Contract standards.
- B. The Contractor shall be responsible for furnishing all equipment, power source when needed, coordinating and performing electrical/electronic testing required by the Contract Documents. Testing requirements may be located on the Contract Drawings or other sections of the specifications.
- C. The Contractor shall provide all necessary assistance and cooperation with any Independent Testing Organization furnishing by the City. The Contractor shall correct, repair, or replace all equipment found to be defective by the Independent Testing Organization.

#### **1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of other requirements of these Specifications, all Work specified herein shall conform to or exceed the applicable requirements of the referenced Standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer's written recommendations:
  - 1. Building Code and DEN Standards.
  - 2. ANSI/IEEE C2 - National Electrical Safety Code.
  - 3. OSHA - Occupational Safety and Health Administration, as Amended
  - 4. NETA - National Electric Testing Association
  - 5. NEMA ICS 1 - General Standards for Industrial Control and Systems.
  - 6. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
  - 7. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
  - 8. UL 1008 - Standard for Automatic Transfer Switches.
  - 9. NFPA 70 - National Electrical Code, including but not limited to use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702.

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**TECHNICAL SPECIFICATIONS  
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10. NFPA 72 - National Fire Alarm Code (as adopted and amended by the Denver Building Code and DEN Standards).
11. NFPA 101 - National Electrical Safety Code (as adopted and amended by the Denver Building Code and DEN Standards).
12. NFPA 110 - Standard for Emergency and Standby Power Systems (as adopted and amended by the Denver Building Code and DEN Standards).
13. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
14. NEMA Standard ICS-2-447 - AC Automatic Transfer Switches.
15. IEC - Standard for Automatic Transfer Switches.

**1.4 SUBMITTALS**

- A. Comply with Division 1 submittal requirements.
- B. Five (5) copies of complete certified test reports shall be submitted to the DEN Project Manager by the contractor. Electronic copy of test reports in pdf format to also be submitted to the DEN Project Manager. The test reports shall include the following as a minimum:
  1. Power cable high potential test reports:
    - a. Insulation resistance tests.
    - b. Continuity tests.
  2. Transformer test reports to include where applicable:
    - a. Transformer turns ratio.
    - b. Winding resistance.
    - c. Insulation power factor.
    - d. K Factor.
  3. All electrical/electronic equipment and systems functional test report.
  4. All other reports required by individual specification sections.

**PART 2 - PRODUCTS****2.1 GENERAL REQUIREMENTS**

- A. The electrical and mechanical equipment shall be completely tested in the field in the presence of DEN Inspectors in accordance with good and accepted industry engineering practices to assure that:
  1. The equipment has not been damaged during manufacturing, shipping, or installation.
  2. The equipment has been installed according to the requirements Contract Documents.
  3. The equipment meets the requirements of the Contract Documents.

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- B. If the Contractor finds during the testing that any piece of equipment failed to satisfactorily pass the required field test, the DEN Project Manager shall be promptly notified and the Contractor shall take the necessary actions for the prompt repair or replacement.
- C. A retest to demonstrate the equipment will meet the requirements of the Contract Documents shall be scheduled with the DEN Project Manager.

## 2.2 GROUND RESISTANCE TEST

- A. Before connecting a ground rod to the system test the resistance to earth. Where test show resistance to ground over 5 OHMS, an additional ground rod shall be added.
- B. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI/IEEE81. Submit test results to the DEN Project Manager

## 2.3 CONDUCTOR INSULATION TEST

- A. Prior to energizing, all building service cables feeders to and/or from transformers, switchboards, panel boards are to be tested with a 1000-volt insulation megohm meter to determine insulation resistance levels. Test cables rated for three hundred volt with a 500-volt megohm meter or as recommended by the manufacturer. All field test data is to be recorded, corrected to a baseline temperature and furnished to the DEN Project Manager. A test is to include meggering between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. Airfield lighting insulation resistance testing shall conform to Item L-108. Insulation test values shall meet or exceed the values given below:

<b>Conductor Size:</b> (AWG or KCMIL)	<b>Resistance:</b> (Megaohms - 1,000 ft.)
12-8	200
6-2/0	100
3/0-750	100

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

- A. TESTING
  1. The Contractor shall allow only certified personnel to perform the testing.
  2. The Contractor shall perform the testing using all necessary safety precautions and proper test equipment.
  3. The Contractor shall notify the DEN Project Manager three (3) days in advance of the proposed testing dates.
  4. Witness of testing by DEN Inspector, Electrical Maintenance and Electrical

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Inspector.

#### **PART 4 - MEASUREMENT**

##### 4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### 5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. Testing, Acceptances, and Certification shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 260510**

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications:
  - 1. Overhead-line grounding.
  - 2. Underground distribution grounding.
  - 3. Ground bonding common with lightning protection system.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to the metallic water pipe service on building side only and to supplementary grounding electrodes, as required by the contract documents and as required by the NEC.
- B. External (underground) metal pipes, water, gas, fuel, drain/sewer etc., are not available for electrical grounding. This is due to extensive cathodic protection and isolation joints of all underground metal pipes at DEN. These systems shall be bonded to the grounding system on the building side only.
- C. Ground each separately derived system neutral to nearest building steel or referenced ground plate in the electrical room.
- D. An insulated equipment ground conductor shall be installed continuous from the main switchgear or service entrance to all branch panelboards, motor control centers, transformers and all motors. This conductor shall be bonded to the conduit and metal enclosures that it passes through utilizing bonding bushings and terminal devices.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

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1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings:
1. Submit shop drawings, coordination drawings, and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.
    - a. Clearly mark each shop drawing as follows for purposes of identification:
      - 1) Shop Drawing
      - 2) Equipment Identification Used on Contract Drawings
      - 3) Date
      - 4) Name of Project
      - 5) Branch of Work
      - 6) Project Manager's Name
      - 7) Contractor's Name
    - b. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.
- C. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
- D. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the Contract Document schedules.
- 1.5 INFORMATIONAL SUBMITTALS<sup>a</sup>
- A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
1. Test wells.
  2. Ground rods.
  3. Grounding arrangements and connections for separately derived systems.
  4. Grounding for sensitive electronic equipment.
- B. Qualification Data: For qualified testing agency and testing agency's field supervisor.
- C. Field quality-control reports.
- 1.6 CLOSEOUT SUBMITTALS

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- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NFPA 70B.
  2. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
  3. Include recommended testing intervals.
- B. Record Documents
1. Maintain a contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries, and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the DEN Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the DEN Project Manager. Follow DEN BIM standards, to be furnished to the successful bidder. Record documents to be provided by the Contractor shall clearly and accurately show the following:
    - a. Provide horizontal and vertical dimensions for all raceway systems, size, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
    - b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
    - c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

## 1.8 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## PART 2 - PRODUCTS

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## 2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Codes.
- B. All ground wires shall be copper, sized according to the NEC or as shown on the drawings whichever is larger.
- C. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
  - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

## 2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connections shall be exothermic welded.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- E. Grounding Connection Accessories:
  - 1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

- B. Ground Rods in manholes ground rods shall be stainless steel ¾-inch diameter and a minimum length of 10 feet.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATIONS**

- A. Conductors: Install solid conductor for No. 12 AWG and smaller, and stranded conductors for No. 10 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 30 inches (750 mm) below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

#### **3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS**

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable

shields according to written instructions by manufacturer of splicing and termination kits.

- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
  2. Lighting circuits.
- C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
  3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- D. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

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- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Item L-115 and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one (1) test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

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**3.5 LABELING**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" Article for instruction signs.

**3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
  4. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  5. Perform tests by fall-of-potential method according to IEEE 81.
  6. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Manhole Grounds: 10 ohms.
  3. Ground resistance to earth of each ground rod: > 5 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify DEN Electrical Engineer promptly and include recommendations to reduce ground

resistance.

#### **PART 4 - MEASUREMENT**

##### 4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### 5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Grounding and Bonding for Electrical Systems shall be considered necessary and incidental to the work of this Contract.

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## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.

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2. Nonmetallic slotted support systems.
3. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

## 1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

## 1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

## 1.8 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

## 1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.10 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## **PART 2 - PRODUCTS**

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
    - h. or approved equal.
  2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4. For use in dry locations only.
  5. Channel Dimensions: Selected for applicable load criteria.
- B. Hardware for hangers and supports shall be corrosion-resistant.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.

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6) or approved equal.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.
7. Pneumatic-Actuated Fasteners: For use in ceilings only and by approval of DEN Project Manager. Powder-actuated tools are prohibited. Threaded-steel stud, for use in pan deck cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Hilti Inc.
    - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 3) MKT Fastening, LLC.
    - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
    - 5) or approved equal.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be **1/4 inch (6 mm)** in diameter.
- C. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2-inch (38-mm)** and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

**3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps, as appropriate and with sufficient weight rating for the application.
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements for a seismic zone 1.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
- G. Do not drill structural steel members.
- H. Install surface-mounted cabinets and panelboards with minimum of four anchors
- I. Suspended conduit or box supports shall not be less than 1/4" diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.
- J. No more than five (5) 1/2" conduits, three (3) 3/4" conduits or two (2) 1" conduits shall be supported on a single 1/4" diameter steel rod.
- K. All conduits shall be supported by approved hangers. Supports installed and used by

other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support.

- L. Use vibration isolation pads for vibrating equipment such as transformers.
- M. Plastic or fiber anchors are prohibited.
- N. Anchoring in overhead cast in place, pre-tensioned or post-tensioned concrete is prohibited unless x-ray or ground penetrating radar study are performed and approved by the DEN Project Manager.
- O. Route conduit through roof openings provided for piping and ductwork where possible; otherwise, route through roof jack with sealant approved by the roofing manufacturer.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Install all freestanding electrical equipment on a 4" concrete housekeeping pad.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- C. Concrete materials, reinforcement, and placement requirements are specified in Item P-610.
- D. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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1. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils** (0.05 mm).
  
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Hangers and Supports for Electrical Systems shall be considered necessary and incidental to the work of this Contract.

END OF SECTION 260529

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**TECHNICAL SPECIFICATIONS  
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## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
  - 1. Include data substantiating that materials comply with requirements.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

#### 1.6 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

### PART 2 - PRODUCTS

#### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Pre-Printed Tags: Polyester tag, 0.010 inch (**0.25 mm**) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

#### 2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Pre-Printed Tags: Polyester tag, 0.010 inch (**0.25 mm**) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

### 2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Pre-Printed Tags: Polyester tag, 0.010 inch (**0.25 mm**) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

### 2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
  1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  2. Printing on tape shall be permanent and shall not be damaged by burial operations.
  3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

**B. Color and Printing:**

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

**C. Tag: Type ID:**

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

**D. Tag: Type IID:**

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
2. Overall Thickness: 8 mils (0.2 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 300 lbf (1334 N), and 12,500 psi (86.1 MPa).

**2.5 WARNING LABELS AND SIGNS****A. Comply with NFPA 70 and 29 CFR 1910.145.****B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.****C. Baked-Enamel Warning Signs:**

1. Preprinted 20 gauge steel signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 14 by 10 inches (360 mm by 250 mm) unless 7 by 10 inches (180 by 250 mm) is the largest size that can be applied where needed.

**D. Metal-Backed, Butyrate Warning Signs:**

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with

- 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Nominal size, 14 by 10 inches (360 mm by 250 mm) unless 7 by 10 inches (180 by 250 mm) is the largest size that can be applied where needed.
- F. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
  3. "XXXX VOLTS"
  4. "KEEP AWAY"
  5. "BURIED CABLE"
  6. "DO NOT TOUCH SWITCH"
- G. Plasticized Tags:
1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, including but not limited to the following legends: "DANGER", "CAUTION", "DO NOT OPERATE".
- ## 2.6 INSTRUCTION SIGNS
- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- ## 2.7 EQUIPMENT IDENTIFICATION LABELS
- A. Adhesive Film Label: Machine printed, in black letters on white background, by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (7 mm).

- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black letters on white background, by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (7 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic, or Melamine Label: Adhesive backed, with black letters on white background. Minimum letter height shall be 1/4 inch (7 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 1/4 inch (7 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (**25 mm**).
- F. Emergency Equipment labels shall be white letters on red background.
- G. Provide nameplates with a minimum letter height as indicated below. Examples are given below for the size of letters to use for a given application and this not a list of the equipment to be identified. All equipment is required to be identified.
  - 1. For equipment designation: switchboards and motor control centers: 1/2 inch, panel boards: 1/4 inch. For voltage, bus ampacity, feeder source, and circuit number: 1/8 inch.
  - 2. Individual circuit breakers and or motor starters in motor control centers: For equipment designation and section number: 1/4 inch, for load served and location of load: 1/8 inch. Inside the door, a typed label shall provide complete motor data including nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
  - 3. Individual breakers in switchgears and switchboards: for breaker number (address number) and equipment designation; 1/4 inch, for breaker frame size and trip setting; 1/8 inch
  - 4. Individual circuit breaker and spaces in panel boards: for numbers (section number) 1/4 inch.
  - 5. Individual circuit breakers in distribution panel boards: 1/4 inch for panel being fed and 1/8 inch for its location.
  - 6. Transformers: 1/4 inch for equipment designation and size; 1/8 inch for primary and secondary voltages, primary source and circuit number, secondary load and its location.
  - 7. Individual remote indicating lights, meters, instruments, and control switches: 1/8 inch, indicate unit, equipment, or fire detector being monitored and condition indicated by illumination.
  - 8. Individual switches and pilots: 1/8 inch, identify mechanical unit being served.
  - 9. Disconnects, relay panels, lighting contactors: 1/4 inch for voltage and source circuit number.

## 2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

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1. Minimum Width: 1/8 inch (3 mm).
  2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
  2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
- 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS
- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

A. Wire and Cable Marker:

1. For wire/cables smaller than No. 2/0 use manufacturer's standard cable/conductor markers of wrap-around, pre-numbered plastic coated type are to be used and numbered to show circuit identification.
2. For cables No. 4 AWG and larger heat shrink sleeving is to be used for phase color-coding.

B. Cable/Conductor Identification:

1. The application of cable/conductor identification, with circuit number, on each wire / cable in each box/enclosure/cabinet is required. The identification shall match the marking system used in panel boards, shop drawings, and contract documents.
  - a. Provide labels on all wires, including in boxes where wires are pulled through but not terminated, such as junction boxes.

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than A, and V to ground: Identify with self-adhesive vinyl label self-adhesive vinyl tape applied in bands. Install labels at maximum intervals.

D. Junction and Pull Box ID: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Power.
2. Fiber Optics: FO.
3. Closed Circuit Television: CCTV.

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for branch-circuit conductors.
  - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
  - b. Colors for 208/120-V Circuits:
    - 1) Phase A: Black.
    - 2) Phase B: Red.
    - 3) Phase C: Blue.
    - 4) Neutral: White
    - 5) Ground: Green

- 6) Isolated Ground: Green with a yellow tracer
- c. Colors for 480/277-V Circuits:
    - 1) Phase A: Brown.
    - 2) Phase B: Orange.
    - 3) Phase C: Yellow.
    - 4) Neutral: Gray
    - 5) Ground: Green
    - 6) Isolated Ground: Green with a yellow tracer
  - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. Install instructional sign including the color-code for conductors using adhesive-film-type labels.
- G. Locations of Underground Lines: Identify with underground-line detectable warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line detectable line marker for encased duct bank, direct-buried cables, and cables in raceway.
- H. Danger Signs:
1. Critical Switches/Controls: Danger signs shall be provided on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation could result in danger to persons, or damage to equipment, or damage to or loss of property.
- I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
- J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Mechanically fastened, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high label; where

two lines of text are required, use labels 2 inches (50 mm) high. Use black lettering on white field for normal and white letters on a red field for emergency. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . . .") and emergency source circuit number when the equipment is a transfer switch or fed directly from a transfer switch.

- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label  
Stenciled legend 4 inches (100 mm) high.
  - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
  - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Panelboards: include main bus ampacity on sign. Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
  - b. Enclosures and electrical cabinets.
  - c. Access doors and panels for concealed electrical items.
  - d. Disconnect switch.
  - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
  - f. Enclosed switches.
  - g. Selector switches, indicating lights. (Circuit number and voltage not required on sign).
  - h. Enclosed circuit breakers.
  - i. Push-button stations.
  - j. Contactors.
  - k. Power-generating units.
  - l. Telephone cabinets and switching equipment. (Circuit number and voltage not required on sign.)
3. All panel boards shall have a typed panel schedule indicating the date, contractor, type of equipment served, and its location.

### 3.3 EQUIPMENT NAMING

- A. Electrical Panels shall be named according to the panel names indicated on the drawings.
- B. Naming Disconnects and Transformers
  1. Disconnects shall have the same as the equipment they serve.
  2. Transformers shall have the same name as the low-voltage panel they supply power to with the extension of -X

**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Identification for Electrical Systems shall be considered necessary and incidental to the work of this Contract.

END OF SECTION 260553

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## SECTION 260573 – ARC FLASH AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.
- C. This section also includes requirements for providing an arc flash hazard analysis and labeling all electrical equipment including switchgear, switchboards, panel boards, transformers, safety switches and other equipment likely to be examined, tested or worked on while energized.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
  - 1. Include data substantiating that materials comply with requirements.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Study and Equipment Evaluation Reports.
  - 3. Coordination-Study Report.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study and arc flash study specialist.
- B. Product Certificates:
  - 1. For coordination-study and fault-current-study computer software programs,

- certifying compliance with IEEE 399.
2. For Arc Flash software program, certifying compliance with IEEE 1584.

## 1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study and Arc Flash study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
  1. CGI CYME.
  2. EDSA Micro Corporation.
  3. ESA Inc.
  4. Operation Technology, Inc.
  5. SKM Systems Analysis, Inc.
  6. ETAP Inc.
  7. or approved equal.

### 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall

demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
  - a. Arcing faults.
  - b. Simultaneous faults.
  - c. Explicit negative sequence.
  - d. Mutual coupling in zero sequence.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
  1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

### **3.2 POWER SYSTEM DATA**

- A. Gather and tabulate the following input data to support coordination study:
  1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Impedance of utility service entrance.
  3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
    - a. Circuit-breaker and fuse-current ratings and types.
    - b. Relays and associated power and current transformer ratings and ratios.
    - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    - d. Generator kilovolt amperes, size, voltage, and source impedance.
    - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    - f. Busway ampacity and impedance.
    - g. Motor horsepower and code letter designation according to NEMA MG 1.
  4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

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- a. Special load considerations, including starting inrush currents and frequent starting and stopping.
- b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

### 3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
  1. DS East RON Panel.
  2. DS East High Mast Lighting Panel (S-19B2H1).
  3. SRE Staging Service Disconnect.
- B. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- C. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
  1. Transformers:
    - a. ANSI C57.12.10.
    - b. ANSI C57.12.22.
    - c. ANSI C57.12.40.
    - d. IEEE C57.12.00.
    - e. IEEE C57.96.
  2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
  3. Low-Voltage Fuses: IEEE C37.46.
- D. Study Report:

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1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

E. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

### 3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
  - a. Inrush current when first energized.
  - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
  - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    - a. Device tag.
    - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    - d. Fuse-current rating and type.
    - e. Ground-fault relay-pickup and time-delay settings.
  2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    - a. Device tag.
    - b. Voltage and current ratio for curves.
    - c. Three-phase and single-phase damage points for each transformer.
    - d. No damage, melting, and clearing curves for fuses.
    - e. Cable damage curves.
    - f. Transformer inrush points.
    - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

### 3.5 Arc Flash Study and labelling requirements

- A. Perform arc study using approved computer software program. Prepare labels that will be affixed to all new electrical equipment being supplied with the project. Comply with IEEE 1584.
1. Display nominal system voltage
  2. Display incident Energy
  3. Display PPE level
  4. Display working distance
  5. Display Arc Flash hazard boundary
  6. Display the equipment name, including the power source it is fed from
- B. Labels to be placed in a location that is clearly visible to qualified persons before they begin work.
- C. Arc Flash labels must be able to withstand their usage environment

## PART 4 - METHOD OF MEASUREMENT

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**4.1 METHOD OF MEASUREMENT**

- A. Arc-Flash and Overcurrent Protective Device Coordination Study will be paid the Contract lump sum to complete the study and accepted by the DEN Project Manager.

**PART 5 - PAYMENT**

**5.1 PAYMENT**

- A. Payment will be made at the Contract unit price per lump sum for Arc-Flash and Overcurrent Protective Device Coordination Study completed in accordance with the plans and specifications by the Contractor and accepted by the DEN Project Manager. This price shall include full compensation for furnishing all labor, materials, equipment, tools, and incidentals and for doing all the work of completing Arc-Flash and Overcurrent Protective Device Coordination Studies to complete this item.

Payment will be made under:

- Item 26 05 73-5.1 Arc-Flash and Overcurrent Protective Device Coordination Analysis – per lump sum

**END OF SECTION 260573**

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## SECTION 260583 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Electrical connections to equipment specified under other Sections or furnished by the Owner.
- B. Applications of electrical power, control and monitoring connections specified in this section include the following:
  - 1. To lighting fixtures and wiring devices.
  - 2. To converters, rectifiers, transformers, inverters, switchgear, switchboards, panel boards, generators, and similar equipment.
  - 3. To grounds including ground electrode connections.
  - 4. Equipment furnished in other Divisions (unless indicated otherwise).
  - 5. Electrical connections for equipment, that are not furnished as integral part of equipment, are specified in Division 27, Division 28 and other Division 26 sections and are criteria of this Section.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

#### 1.3 ACTION SUBMITTALS

#### 1.4 CLOSEOUT SUBMITTALS

- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.5 QUALITY ASSURANCE

- A. Products, materials, equipment, and systems shall comply with the following Codes and Standards:
  - 1. NFPA Compliance: NFPA 70, "National Electrical Code (NEC)" as adopted and

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amended by the Denver Building Code and as applicable to products used and the installation of electrical power connections (terminals and splices), junction boxes, motor starters and disconnect switches.

2. IEEE Compliance: Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.
3. ANSI Compliance: Applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
4. UL Compliance: UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Electrical connection products and materials are to be UL-listed and labeled.

## 1.6 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND COMPONENTS

- A. Products shall be as specified in other Sections of this Division.
- B. General: Each electrical connection shall be a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, stress cones, splice kits, termination kits, solder less wire nuts, and other items and accessories as needed to complete splices and terminations as required.
  1. Connectors and Terminals: Electrical connectors and terminals shall mate and match, including sizes and ratings, with equipment terminals that are recommended by equipment manufacturer for intended applications.
  2. Electrical Connection Accessories: Electrical insulating tape, heat-shrinkable insulating tubing and boots, stress cones, splice kits, termination kits, wirenuts, and cable ties as recommended for use by accessories manufacturers for type of services required.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

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**3.2 PREPARATION**

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

**3.3 INSTALLATION**

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations. Length shall be six feet (6') maximum.
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring as required for a complete operating system.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as required for a complete operating system. Connect with conduit and wiring as required for a complete operating system.

**3.4 EQUIPMENT CONNECTION SCHEDULE**

- A. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Division 26 of the technical specifications.

**3.5 INSTALLATION OF ELECTRICAL CONNECTIONS**

- A. Electrical connections shall be installed in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
  - 1. As a minimum: Each feeder circuit to panelboards, switchboards, motor control centers, transformers, and 480-volt (and higher) motor circuits shall have an insulated equipment ground conductor.
  - 2. Electrical service and feeders are to be maintained to occupied areas and operational facilities when temporary service is required during interruptions to existing facilities. Momentary outages for replacing existing wiring systems with new wiring systems shall be scheduled. When the "cutting-over" has been successfully accomplished, temporary wiring is to be removed.

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3. Splices shall be covered with electrical insulating material equivalent to, or of greater insulation rating, than electrical insulation rating of those conductors being spliced.
4. Cables and wires shall be trimmed as long as practicable and routing shall be arranged to facilitate inspection, testing, and maintenance.
5. Connectors and terminals, including screws and bolts, shall be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Proper torqueing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings shall be used to comply with torqueing values contained in UL 496A or the manufacturer's literature.
6. Identification markers are to be fastened to each electrical power supply wire/cable conductor in accordance with Section 260553 "Identification for Electrical Systems".
  - a. Markers are to be affixed on each terminal conductor, as close as possible to the point of connection.

### 3.6 FIELD QUALITY CONTROL

- A. The correct direction of rotation of each motor is to be verified.
- B. Provide measured torqueing value checklist with witness signature to DEN Project Manager.

## PART 4 - MEASUREMENT

### 4.1 MEASUREMENT

- A. No separate measurement will be made for the work specified in this Section.

## PART 5 - PAYMENT

### 5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Electrical Connections for Equipment shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 260583**

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Photoelectric switches.
  - 2. Lighting contactors.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Interconnection diagrams showing field-installed wiring.
  - 2. Include diagrams for power, signal, and control wiring.
- C. Coordination Drawings: Include drawings to show lighting control equipment layouts and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.
- B. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.
- C. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Testing agency as defined by OSHA 29 CFR 1910.7, or a member company of the International Electrical Testing Association that is acceptable to authorities having jurisdiction.
- B. Source Limitations: Obtain lighting control equipment components through one source from a single manufacturer.
- C. Firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of lighting control equipment for not less than five (5) years.

**1.7 WARRANTY**

- A. Manufacturer shall provide a product warranty for a period of not less than two (2) years from date of installation. Warranty shall cover unlimited replacement of lighting control equipment modules during the warranty period.

**1.8 SEQUENCING AND SCHEDULING**

- A. The lighting control equipment installation is to be sequenced and scheduled with other work to reduce possibility of damage to equipment during the remainder of construction period.
- B. Power Outages: Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

**1.9 EXTRA MATERIALS**

- A. Furnish extra materials including ten (10) percent of installed units, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver materials as directed by DEN Project Manager.

**1.10 ENVIRONMENTAL CONDITIONS**

- A. The lighting control equipment unit shall be capable of continuous operation under the following temperature conditions:
1. Relative humidity: 95% non-condensing.
  2. Altitude: 5500 feet (1667 meters) without any de-rating.
  3. Functioning: -30°F (-34°C) (Outdoor) to 120°F (49°C) (Indoor & Outdoor).
  4. The neutral shall not be combined for lighting circuits with electronic or dimming ballasts, and should be bonded according to local codes and National Electrical Code (NEC).

**1.11 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 TIME SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
  2. Intermatic, Inc.
  3. Invensys Controls.
  4. Leviton Manufacturing Co., Inc.
  5. NSi Industries LLC; TORK Products.
  6. Tyco Electronics; ALR Brand.
  7. or approved equal.

**2.2 OUTDOOR PHOTOELECTRIC SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.

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2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products.
4. Tyco Electronics; ALR Brand.
5. or approved equal.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 5.5 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Lightning Arrester: Air-gap type.
5. Mounting: Twist lock complying with NEMA C136.10, with base.

### 2.3 PHOTOELECTRIC CONTROL

A. Description: Completely self-contained, adjustable type, in NEMA 1 enclosure with adjustable 0 to 15 minute minimum time delay to provide a dead band zone for temporary changes in daylighting.

B. Automatic Operation:

1. Daylight Only Lighting Level 50 Footcandles or More: No fixtures on.
2. Daylight Only Lighting Level less than 50 Footcandles: Photocell No. 1 (PC 1) activates SW 1 lamps in Daylighting fixtures.
3. Daylight Only Lighting Level Less than 25 Footcandles: Photocell No. 2 (PC 2) activates SW 2 lamps in Daylighting fixtures with SW 1 lamps previously activated. All fixture lamps activated.

C. Footcandle Lighting Level Readings: Measured at the "Workplane" at 3 feet above finish floor.

- 1.

**2.4 LIGHTING CONTACTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
  2. ASCO Power Technologies, LP.
  3. Eaton Corporation.
  4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
  5. Square D.
  6. or approved equal.
- B. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

**2.5 CONDUCTORS AND CABLES**

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Item L-108.
- B. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Item L-108.

**PART 3 - EXECUTION****3.1 SENSOR INSTALLATION**

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

**3.2 CONTACTOR INSTALLATION**

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

**3.3 WIRING INSTALLATION**

- A. Wiring Method: Minimum conduit size is 3/4 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Tighten lighting control equipment assembly joints with torque wrench or similar tool recommended by bus assembly manufacturer. Tighten joints again after lighting systems have been energized for 30 days.
- F. Connect lighting control equipment assemblies and components to wiring system and to ground as indicated and instructed by manufacturer.
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- H. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.

**3.4 IDENTIFICATION**

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

**3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Manufacturer's representative shall visit site, verify installation, start up and test, and submit to DEN Project Manager, a letter stating equipment and installation meets intent of Contract Documents and manufacturer's warranties and guarantees are in effect
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

**3.6 CLEANING**

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finish to match original finish.

**3.7 PROTECTION**

- A. Provide final protection to ensure that moisture does not enter lighting control equipment assembly.

**3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.
  - 1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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TECHNICAL SPECIFICATIONS  
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SECTION 260923 – LIGHTING CONTROL DEVICES

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**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. Lighting Control Devices shall be considered as included in Exterior Lighting - Airside pay items and no additional compensation will be allowed.

**END OF SECTION 260923**

**SECTION 262200 - LOW-VOLTAGE TRANSFORMERS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

**1.3 ACTION SUBMITTALS**

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
  - 1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined for Seismic Zone-1.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- B. Handle using only lift eyes and provided brackets. Protect equipment in inclement weather.

#### 1.8 COORDINATION

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- A. For floor-mounted transformers, coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. For wall-mounted and structure-mounted transformers, coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

**1.9 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Match existing equipment in the vicinity, if applicable. Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
  - 2. General Electric Company.
  - 3. Square D; Schneider Electric.
  - 4. or approved equal.

**2.2 GENERAL TRANSFORMER REQUIREMENTS**

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Internal Coil Connections: Brazed or pressure type.
  - 2. Coil Material:
  - 3. Transformers rated up to 45kVA: Copper or Aluminum.
    - a. Transformers rated above 45kVA: Copper windings are required.

**2.3 DISTRIBUTION TRANSFORMERS**

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, . NEMA 250, Type 3R.

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1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.
- E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
  2. Tested according to NEMA TP 2.
- I. Wall Brackets: Manufacturer's standard brackets.
- J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91. Maximum sound levels shall be as follows:
1. 1 to 5 kVA: 37dB.
  2. 6 to 25 kVA: 42dB.
  3. 26 to 150 kVA: 47dB.

**2.4 IDENTIFICATION DEVICES**

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
1. Include transformer connection data and overload capacity based on rated allowable temperature rise.

**2.5 SOURCE QUALITY CONTROL**

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

**3.3 CONNECTIONS**

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Item L-108.

**3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including

connections, and to assist in testing.

- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform two (2) follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### 3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

### 3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

## **PART 4 - MEASUREMENT**

### 4.1 METHOD OF MEASUREMENT

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- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.1 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this Section. Low Voltage Transformers shall be considered necessary and incidental to the work of this Contract.

END OF SECTION 262200

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**SECTION 262416 - PANELBOARDS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Distribution panelboards.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

**1.3 DEFINITIONS**

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
  - 1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations

- of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  3. Detail bus configuration, current, and voltage ratings.
  4. Short-circuit current rating of panelboards and overcurrent protective devices.
  5. Include evidence of NRTL listing for series rating of installed devices.
  6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  7. Include wiring diagrams for power, signal, and control wiring.
  8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field Quality-Control Reports:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Panelboard Schedules: For installation in panelboards.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: Two (2) spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types.

3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

#### 1.9 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

#### 1.11 PROJECT CONDITIONS

- A. Environmental Limitations:
  1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding minus 30 deg F (minus 35 deg C) to plus 120 deg F (plus 49 deg C).
    - b. Altitude: **5500 feet** (1677 m), not exceeding **6600 feet** (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  1. Ambient temperatures within limits specified.
  2. Altitude: 5500 feet, not exceeding **6600 feet** (2000 m).

- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
  2. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
  3. Comply with NFPA 70E.

#### 1.12 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.13 WARRANTY

- A. Special Warranty: for Surge Suppression Devices Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Minimum five (5) years from date of Substantial Completion.

#### 1.14 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section "Vibration and Seismic Controls for Electrical Systems."

- B. Enclosures: Surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
  2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  6. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Same finish as panels and trim.
  7. Enclosures shall be at least 20 inches wide made from galvanized sheet steel in the sizes and NEMA types indicated, code gauge, minimum 16 gauge thickness
  8. Directory Card: Inside panelboard door, mounted in transparent card holder .
- C. In all cases where the conductor to be connected to the busbar is 1/0 or larger cable, the connection shall be made with a 2-hole compression lug. Torque all lug, wire and bus terminations to the manufacturers recommendation using a micrometer type wrench.
- D. Incoming Mains Location: Bottom.
- E. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  4. Split Bus: Vertical buses divided into individual vertical sections.
- F. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Main and Neutral Lugs: Mechanical type.
  3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

- I. Breakers shall have built-in test points for testing long delay, and instantaneous functions of the breaker by means of a 120 volt operated test kit.
  
- J. General Requirements for Branch Circuit Panelboards:
  - 1. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers, of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
  - 2. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and up through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as Type SWD for lighting circuits.
    - a. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.
    - b. Main circuit breaker, when shown, shall be vertical mounted top or bottom as required. Chassis mounted reverse fed main circuit breaker is not acceptable.
  - 3. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts and 14,000 amperes symmetrical at 480 volts.

## 2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Match existing manufacturer in the immediate area, if applicable. Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Square D; a brand of Schneider Electric.
  - 4. or approved equal.
  
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
  
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
  
- D. Mains: Circuit breaker.
  
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
  
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Square D; a brand of Schneider Electric.
  4. or approved equal.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully-rated interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 600 A and below.
  2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
    - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
  2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

## 2.4 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology; a subsidiary of Danahar Corporation.
  2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  4. Liebert Corporation.
  5. Square D; a brand of Schneider Electric.
  6. or approved equal.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
    - a. LED indicator lights for power and protection status.
    - b. Audible alarm, with silencing switch, to indicate when protection has failed.
    - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
    - a. LED indicator lights for power and protection status.
    - b. Audible alarm, with silencing switch, to indicate when protection has failed.
    - c. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    - d. Four-digit, transient-event counter set to totalize transient surges.
  2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
  3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
    - a. Line to Neutral: 70,000 A.
    - b. Line to Ground: 70,000 A.
    - c. Neutral to Ground: 50,000 A.
  4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 -V, three-phase, four-wire circuits shall be as follows:
    - a. Line to Neutral: 800 V for 480Y/277.
    - b. Line to Ground: 800 V for 480Y/277.

- c. Neutral to Ground: 800 V for 480Y/277.
- 5. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:
  - a. Line to Neutral: 400 V.
  - b. Line to Ground: 400 V.
  - c. Neutral to Ground: 400 V.
- 6. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
  - a. Line to Neutral: 400 V, 800 V from high leg.
  - b. Line to Ground: 400 V.
  - c. Neutral to Ground: 400 V.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Comply with mounting and anchoring requirements specified in Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim **78 inches (1982 mm)** above finished grade unless matching height of existing equipment or approved otherwise.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

- E. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub five 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub five 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Comply with NECA 1.

### 3.3 PANELBOARD SCHEDULE

- A. Panelboards shall be furnished and equipped as follows, except as otherwise specified:

Manufacturer:	120/208V:	277/480V:
Cutler Hammer	PRL-1	PRL-2
Square-D	NQOD	NEHB
GE	NLAB	NHB

Or approved equal by other manufacturer.

- B. Distribution panelboard shall be scheduled where more than one subfeed breaker rated in excess of 100A is required, and for any panelboard containing breakers with ratings of 225A or more.

### 3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Clearly identify the load on each circuit, equipment serviced and location. Revise directory to reflect circuiting changes required to balance phase loads. In all instances where a contractor installs or disconnects a circuit in any panel, a newly typed panel schedule shall be furnished. The new or revised panel schedule shall have the date and Contractor's name typed at the top right hand corner. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with

a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections, preparing a written report for each including test results:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard eleven (11) months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Submit torque values for all connections with a torque schedule and witness signature.

**3.6 ADJUSTING**

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

**3.7 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

**PART 4 - MEASUREMENT****4.1 METHOD OF MEASUREMENT**

- A. Panelboards and receptacle arrays will be paid the Contract lump sum for each type installed, complete, and in-place, ready for operation, and accepted by the DEN Project Manager.

**PART 5 - PAYMENT****5.1 PAYMENT**

- A. Payment will be made at the Contract unit price per lump sum for each item completed in accordance with the plans and specifications installed by the Contractor and accepted by the DEN Project Manager. This price shall include full compensation for furnishing all labor, materials, equipment, tools, assembly and installation of these materials, and incidentals necessary to complete this item.

Payment will be made under

Item 26 24 16-5.1 Install DS East MDP Panel – per lump sum

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Install MDP panel, 480Y/277V, 3P, 4W, NEMA-3R including, fused service disconnect switch, CT cabinet, meter socket, coordination with Xcel Energy, circuit breakers, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, conduit between service and Xcel Energy transformer, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.2 Install DS East Lighting Panel – per lump sum

Install DS East Lighting panel, 480Y/277V, 3P, 4W, NEMA-3R including, circuit breakers, lighting control enclosure (complete), manual 3-position switch for light level control, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.3 Install SRE Crew Panel – per lump sum

Install SRE Crew panel, 208Y/120V, 3P, 4W, NEMA-3R including, pad-mounted transformer, fusible safety switches, fuses, circuit breakers, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, liquid tight flex conduit, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.4 Install SRE Receptacle Panel – per lump sum

Install SRE Crew panel, 208Y/120V, 3P, 4W, NEMA-3R including, pad-mounted transformer, fusible safety switches, fuses, circuit breakers, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, liquid tight flex conduit, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.5 Install SRE Receptacle Rack Arrays – per lump sum

Install SRE receptacle rack arrays including, double block and double rail barrier, steel posts, NEMA 4X enclosures, PVC coated RGS conduit, RGS conduit, liquid tight flex conduit, branch circuit cables from SRE Receptacle Panel, NEMA 3R power outlet control panels, red pilot lights, power cable and receptacle factory assembled cord sets, water tight strain relief connector, steel channel, pipe clamps, and all necessary incidentals to complete this item.

**END OF SECTION 262416**

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## **SECTION 262813 - FUSES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in control circuits and enclosed switches.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
  - 5. Coordination charts and tables and related data.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
  2. Current-limitation curves for fuses with current-limiting characteristics.
  3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
  4. Coordination charts and tables and related data.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.

**1.6 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

**1.7 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

**1.8 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**1.9 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann.
  2. Edison; a brand of Cooper Bussmann.
  3. Ferraz Shawmut, Inc.
  4. Littelfuse, Inc.
  5. General Electric.
  6. Gould.
  7. Reliance.
  8. or approved equal.

**2.2 CARTRIDGE FUSES**

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 FUSE APPLICATIONS**

**A. Cartridge Fuses:**

1. Service Entrance: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class J, fast acting Class J, time delay Class T, fast acting.
2. Feeders: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class RK5, fast acting Class RK5, time delay Class J, fast acting.
3. Control Circuits: Class CC, fast acting time delay.

**3.3 INSTALLATION**

- A.** Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

**3.4 IDENTIFICATION**

- A.** Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

**PART 4 - MEASUREMENT**

**4.1 METHOD OF MEASUREMENT**

- A.** No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.1 METHOD OF PAYMENT**

- A.** No separate payment will be made for work under this Section. Fuses shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 262813**

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Molded-case circuit breakers (MCCBs).
  - 3. Enclosures.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

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1. Enclosure types and details for types other than NEMA 250, Type 1.
  2. Current and voltage ratings.
  3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  4. Include evidence of NRTL listing for series rating of installed devices.
  5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
  7. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.
1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Manufacturer's field service report.
- 1.7 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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**1.8 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.
  - 2. Fuse Pullers: Two (2) for each size and type.

**1.9 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

**1.10 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 30 deg F (minus 35 deg C) and not exceeding 120 deg F (49 deg C).
  - 2. Altitude: 5500 feet (1677 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
  - 2. Indicate method of providing temporary electric service.

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3. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
4. Comply with NFPA 70E.

**1.11 COORDINATION**

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**1.12 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 FUSIBLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. or approved equal.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

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4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

**2.2 MOLDED-CASE CIRCUIT BREAKERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. or approved equal.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
  2. Long- and short-time pickup levels.
  3. Long- and short-time time adjustments.
  4. Ground-fault pickup level, time delay, and  $I^2t$  response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

**2.3 ENCLOSURES**

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Outdoor Locations: NEMA 250, Type 3R.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

**3.3 IDENTIFICATION**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

**3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.5 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
  - B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

**PART 4 - MEASUREMENT****4.1 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.1 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this Section. Enclosed Switches and Circuit Breakers shall be considered necessary and incidental to the work of this Contract.

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**END OF SECTION 262816**

## SECTION 265650 - EXTERIOR LIGHTING - AIRSIDE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. This Section defines performance and design standards for area lighting located on the airside, primarily at aircraft parking, servicing, and holding positions.

B. The lighting fixture selections and layouts shown on the drawings are to be used in conjunction with the requirements contained in this Section. Contractor shall engage the services of a qualified lighting design firm or manufacturer to provide a fully engineered lighting design.

C. All lighting components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers, and enclosures shall be factory assembled, aimed, wired, and tested.

D. Contractor shall furnish and install all lighting equipment and lighting fixtures including poles, luminaires, drivers, control equipment, etc., as required for all areas in accordance with the accepted lighting design and shop drawings.

E. The contractor's lighting installation shall meet the following primary goals:

1. Spill and glare control: The primary objective of airside lighting installations is to provide the specified lighting while minimizing spill light, up-light, direct glare, and indirect (reflected) glare.
2. Guaranteed light levels: Provide light sources that are configured to maintain consistent target light levels as specified herein for a minimum period of 10 years from substantial completion.
3. Total cost of ownership: Provide energy-efficient, long-lasting light sources. Any required repairs or maintenance to maintain specified light levels over the 10-year warranty performance period shall be included in the project.

F. Airside lighting shall comply with FAA AC 150/5360-13A, IES RP-37-15, and all requirements contained in this Section.

G. Section Includes:

1. Exterior airside LED luminaires with remote drivers.
2. Poles and accessories.
3. Control devices.

H. Related Sections:

I. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

### 1.3 DEFINITIONS

A. ADG: Aircraft Design Group. Aircraft sizing criteria defined by the FAA. Ranges from ADG I (smallest) to ADG VI (largest).

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. Ground Load Gate: An aircraft loading gate without an enclosed passenger loading bridge. Ground load gates may or may not be located adjacent to a building.

E. HID: High-intensity discharge.

F. LER: Luminaire efficacy rating.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

H. Mainline Gate: An aircraft loading gate equipped with an enclosed passenger loading bridge and associated service facilities. Mainline gates are typically designed to service aircraft in ADG III and above, but occasionally may service smaller aircraft.

I. Pole: Luminaire support structure, including tower used for large area illumination.

J. Remain Overnight (RON) Pad: An aircraft parking position that is not used or intended for passenger loading.

K. Standard: Same definition as "Pole" above.

L. Taxilane: The section of aircraft taxiing route located closest to each concourse, utilized for aircraft push-back. Commonly identified with a purple centerline marking.

M. Taxiway: Aircraft taxiing routes, other than taxilanes as defined above.

N. VSR: Vehicle Service Road. Ground-based vehicle roads located on the airfield.

### 1.4 LIGHTING PERFORMANCE REQUIREMENTS

A. Illumination levels: Lighting shall meet the illumination targets as specified below. Contractor shall provide a comprehensive lighting design submittal and field measurements in accordance with this Section to document compliance with requirements. The deice parking positions and the SRE/GSE staging pad shall meet the following horizontal illumination (footcandle) requirements using a 10-foot by 10-foot grid.

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Area	Average	Min	Max
Deice Pad	2.0	0.45	6.0
SRE/GSE Staging	0.95	0.15	2.0

- B. Hours of usage: Airside area lighting shall be provided with daylight-responsive controls to operate from dusk to dawn daily. Annual and 10-year usage shall be assumed to be as follows:

Area	Annual Usage, hours	10-year usage, hours
Remain Overnight (RON) Positions	5,000	50,000

- C. Spill and Glare Control:

- All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shield, louvers, and external shields. Symmetrical flood beam patterns are prohibited.
- Glare control: Candela values contributed by the project shall not exceed the following:

Area	Maximum
Taxiway CN centerline	5,000 Cd
Concourse A & B ramp tower cabs	0 Cd
FAA Control tower cab	0 Cd

- D. Spill scans: Photometric measurements shall include horizontal and vertical spill scans at the horizontal and vertical boundary lines as specified in the lighting performance requirements above.

- E. Dusk-to-dawn lighting control:

- Lighting system shall be equipped with daylight-responsive controls to enable activation of lighting system at dusk, and deactivation of system at dawn.
- Utilize photoelectric sensors connected to a networked lighting control system to provide dusk-to-dawn control.
- Lighting control system shall be integrated with the DEN EMCS using standard BACNet communication protocols.
- Provide 3-position switch adjacent to lighting control enclosure to manually set light output at 33%, 50%, and 100% of rated light output.

## 1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.

- C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
1. Basic wind speed for calculating wind load for poles exceeding 50 feet (15 m) in height is 115 mph.
    - a. Wind Importance Factor: 1.3
    - b. Minimum Design Life: 50 years.
    - c. Velocity Conversion Factors: 1.3

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  2. Details of attaching luminaires and accessories.
  3. Details of installation and construction.
  4. Luminaire materials.
  5. Wind loading data.
  6. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, remote driver, and accessories.
    - a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  7. Photoelectric relays.
  8. Drivers, including energy-efficiency data.
  9. Solid-State Lamps, including rated life, output, CCT, CRI, lumens, and energy-efficiency data.
  10. Materials, dimensions, and finishes of poles.
  11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  12. Anchor bolts for poles.
  13. Manufactured pole foundations.
  14. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Lighting design drawings, including:
    - a. Area name, date, file number.
    - b. Site plan of project areas, indicating pole locations, surrounding buildings, and horizontal illuminance levels at specified grid spacing and calculation plane height.

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- c. Photometric statistics, including average, minimum, and maximum foot-candles in the lit area; uniformity (max/min); horizontal and vertical illuminance at area boundaries.
  - d. Spill scans, showing maximum candela at specified glare control locations and starting at the edge of the lit area continuing until 500 candela or less is achieved.
  - e. Overall statistics, including power consumption (initial and 10-year); average tilt factor; light loss factor.
  - f. Overall pole height(s), number of fixtures per pole, horizontal and vertical aiming angles.
  - g. Luminaire wattage, lumen output, and optical configuration.
- 2. Engineered structural design for poles, for pole foundations, signed and sealed by a professional structural engineer licensed in the state of Colorado.
  - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  - 5. Wiring Diagrams: For power, signal, and control wiring.
- C. EMCS Graphics Pages: For lighting controls integration.
- D. Substitutions: For Pre-bid approval, submit all materials noted in paragraphs A and B above.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- B. Qualification Data:
  - 1. For qualified agencies providing photometric data for lighting fixtures.
  - 2. For lighting designer: Submit (3) example projects in which the lighting designer served as the principal in charge of the lighting design.
  - 3. For structural engineer: Licensing information.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1. Include contact information for the manufacturer's local service representative, to be contacted in the event of a manufacturer warranty issue.
- B. Connectors and terminals, including screws and bolts, are to be tightened in accordance with equipment manufacturer's published torque tightening values. Record all torque values for bolts and submit report with witness signature to DEN Project Manager.
- C. Contractor shall provide to the DEN Project Manager a Point by Point report showing the light level readings taken after the luminaires have been properly aimed and have had at least 50 hours of actual run time in the field. The grid spacing for the readings shall be the same as the calculations submitted prior to start of construction.
  1. For luminaires with step-dimming control, provide an additional point-by-point report showing light level readings
- D. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials as directed by DEN Project Manager.
  1. Luminaires: Five (5) percent of the total number of luminaires, but not less than two (2) luminaires, for each type and rating installed.
  2. Drivers: One (1) for every 50 of each type and rating installed. Furnish at least one of each type.
  3. Fuses: One (1) for every 50 of each type and rating installed. Furnish at least two of each type.

#### 1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the latest edition of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and

application.

- E. Comply with IEEE C2, "National Electrical Safety Code."
- F. Comply with NFPA 70.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to:
  - 1. Repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period.
  - 2. Guarantee overall light levels as specified in this Section, with a total lumen depreciation factor of 0.95 over the warranty period to account for dirt depreciation and other environmental factors.
  - 3. Manufacturer agrees to repair or replace luminaires in the event that light levels are found to be out of compliance with the specified levels.
  - 4. Manufacturer agrees to provide a factory-authorized service representative onsite at the time of any warranty repairs to coordinate with DEN operations and maintenance staff and provide any required labor necessary to perform necessary warranty repair work.
- B. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
- C. Lighting supplier shall warrant the complete installation, including poles, hardware and accessories. In cases where the lighting supplier is not a manufacturer of poles, lighting supplier shall fully warrant the poles and any other 3<sup>rd</sup>-party hardware as a first-party product, in order to provide a single point of contact and service for all warranty-related issues for the entirety of the warranty period.
- D. Warranty Period: Minimum ten (10) years from date of Substantial Completion.

#### 1.10 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, provide products for luminaires, poles and accessories from one of the following:
1. Musco Lighting, LLC.
  2. Acuity Lighting.
  3. Eaton/Cooper Lighting.

**2.2 GENERAL REQUIREMENTS FOR LUMINAIRES**

- A. Environmental Conditions:
1. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:
    - a. Location: Outdoors.
    - b. Altitude: 5,500 feet (1677 m) above sea level.
    - c. Ambient Temperature Range: Minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C).
    - d. Wind Load: 115 mph with gust factor of 1.3.
- B. Provide lighting equipment as shown on the drawings and as specified herein. Provide complete lighting equipment, including canopies, poles, supporting brackets, hickies, casing, socket holders, reflectors, drivers, solid-state lamps, etc., as appropriate for the application. Provide special plates, barriers, rings, etc., as required to comply with National Electrical Code. The fixtures to have proper gasketing and made of corrosion resistant materials to be installed in damp and wet locations.
- C. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

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- H. Exposed Hardware Material: Stainless steel.
- I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- J. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- K. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
  2. Specular Surfaces: 83 percent.
  3. Diffusing Specular Surfaces: 75 percent.
- L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- M. Constant Lumen Output: Overall lumen output of luminaires shall not degrade by more than 5% over the 10-year warranty period. Products provided shall employ constant lumen output drivers, designed to compensate for lumen depreciation over the life of the lamps.
1. Projected non-compensated lumen maintenance shall be at least 70% of original output at 100,000 hours, as measured in accordance with IES TM-21.
- N. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  2. Exterior Surfaces: Manufacturer's hot-dip galvanized finish.
    - a. Color: Grey.
- P. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I,

clear coating 0.018 mm or thicker) complying with AAMA 611.

Q. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

- a. "USES ONLY" and include specific lamp type.
- b. CCT and CRI for all luminaires.

## 2.3 OUTDOOR PHOTOELECTRIC SENSORS

A. Comply with Section 260923 "Lighting Control Devices" for outdoor photoelectric sensors.

## 2.4 DRIVERS FOR SOLID-STATE LAMPS

A. Description: Listed, electronic, RoHS compliant, meeting the requirements of ANSI C82.77 and UL 8750.

1. Remote drivers shall be provided, integral driver luminaires will not be accepted.

2. Dimming: Where required. Meet or exceed specified dimming percentage. Provide 4-wire (0-10V DC Voltage Controlled) dimming drivers which meet the following requirements:

- a. Compatible with solid-state devices within the range of 10%-100% of the power supply output.
- b. Meet IEC 60929 Annex E for General White Lighting LED drivers.
- c. Connect to devices compatible with class 2 0-10V analog control protocol.
- d. 0-10V control interface shall be completely isolated from the line-voltage AC power supply.
- e. Available sink current for each driver on the 0-10V interface shall not exceed 1 mA.

3. Temperature rating: Match or exceed environmental requirements.

4. Rated Life: 100,000 hours minimum.

5. Manufacturer's Warranty: Five (5) years minimum.

6. Input voltage range: 120-480 VAC, +/- 10%.

7. Power factor: 0.9, minimum.

8. THD: 10% maximum at full load.

9. Efficiency: 85% minimum at full load.

10. Provide surge protection for drivers at each light pole. Surge protection rating shall be 40kA minimum for each line-to-ground (common mode) as recommended by IEEE C62.41.2.

**2.5 SOLID-STATE LAMPS**

- A. LED lamps: ANSI C78.377, listed and rated for the intended environmental conditions.
- B. Color Rendering:
  - 1. Minimum CRI: 70.
- C. Correlated color temperature (CCT): 4000K.
- D. Minimum LED life: 50,000 hours at a depreciation-compensated lumen output no less than 95% of original output, including environmental factors. 100,000 hours minimum to a non-compensated output of 70%. Lumen maintenance measurements and calculations must conform to IES LM-80 and IES TM-21.
- E. Lumen output shall be as specified in the shop drawing submittal. Conform to IESNA LM-79.

**2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS**

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
  - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
  - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.3 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor bolts shall meet or exceed wind loading and structural requirements.
  - 3. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  - 4. Anchor-Bolt Template: Plywood or steel.
  - 5. Ground bolt near the handhole shall be included.
- D. Handhole: Oval-shaped, reinforced, with minimum clear opening of 3 inches by 5 inches (76 by 130 mm) minimum, with cover secured by stainless-steel captive screws. Provide larger size handholes to suit pole diameter.
- E. Concrete Pole Foundations: Precast with concrete backfill or cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Item P-610.

**F. Lightning protection:**

1. Manufacturer shall provide integrated lightning grounding via concrete encased electrode grounding system as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode Comply with Section 260526 "Grounding and Bonding for Electrical Systems," with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2/0 AWG for poles with more than 75 feet mounting height.

**2.7 STEEL POLES**

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction with access handhole in pole wall.
  1. Shape: Round, tapered.
  2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with hot-dip galvanized steel bolts.
  2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- G. Hot-Dip Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent

- Cleaning," to remove dirt, oil, grease, and other contaminants that could impair bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: Factory hot-dip galvanized finish.
  3. Exterior Surfaces: Factory hot-dip galvanized finish.
    - a. Color: Grey.

## 2.8 POLE ACCESSORIES

- A. Driver enclosure: NEMA 3R, lockable, hinged steel enclosure, sized to accommodate all remote drivers, fuses, and accessories required. Painted to match pole finish.
  1. Mounting: secured to pole with stainless steel fasteners.
  2. Provide opening from rear of driver enclosure into pole interior, sized as required, to conceal all wiring from power supply to drivers and from drivers to luminaires.
  3. Mounting height: 10 feet above finished grade to bottom of enclosure.
  4. Drivers, fuses and other devices shall be securely mounted to enclosure using DIN rail or steel backplane.
  5. Enclosure shall be capable of being opened during operation without interrupting power to luminaires.
- B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

## PART 3 - EXECUTION

### 3.1 INSTALLATION GENERAL

- A. Sequence and Schedule: The exterior lighting installation is to be sequenced and scheduled with other work to reduce possibility of damage and soiling of fixtures during the remainder of construction period.
- B. Power Outages: Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
- C. Photocells and Timers: The fixtures shall operate on the voltage shown. Provide and install all photocells and/or timer devices for automatic operation of the fixtures as described in the construction documents. Refer to lighting control specification sections for additional requirements.
- D. Torque Values: Connectors and terminals, including screws and bolts, are to be tightened in accordance with equipment manufacturer's published torque tightening values. Record all torque values for bolts and submit report with witness signature to DEN Project Manager.

### 3.2 LUMINAIRE INSTALLATION

- A. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- B. Engage the services of a factory-authorized representative to adjust luminaires that require field adjustment or aiming.

### 3.3 POLE INSTALLATION

- A. The pole will be installed according to the manufacturer's recommendations.
- B. Pole layout: As shown on drawings.
  - 1. Poles shall not be located within 25 feet of the edge of any aircraft safety envelope.
  - 2. Pole locations shall be selected to minimize interference with ground service equipment operation and maneuvering.
  - 3. Final pole layouts must be approved by airside operations and airport planning.
- C. Grounding will comply with National Electrical Code requirements.
- D. Provide individual fuses at each pole for each driver, installed in the remote driver enclosure.
- E. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- F. Clearances: Maintain the following minimum clear horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (**1520 mm**).
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (**3 m**).
- G. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Item P-610.
- H. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers unless otherwise indicated.
  - 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

- I. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
  - 1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
  - 2. Fill augered hole around pole with concrete per Item P-610, and finish in a dome above finished grade.
  - 3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
  - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- J. Raise and set poles using web fabric slings (not chain or cable).

### 3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Item L-110. In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Luminaires shall be factory-aimed to conform with the accepted lighting design shop drawings. If factory aiming is not possible, provide a manufacturer's service representative onsite to observe and direct fixture aiming during installation.
- C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - 1. Verify operation of photoelectric controls.
- D. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

a. IESNA RP-37-15, "Outdoor Lighting for Airport Environments," annex B.

- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- F. Cleaning: Clean all fixtures of dirt and debris upon completion of the installation and protect fixtures from damage during construction period.

### 3.7 DEMONSTRATION

- A. Demonstrate capability and compliance with specified requirements upon completion of installation of exterior lighting fixtures and associated circuiting.
- B. All lighting fixtures having an adjustable type beam spread or pole mounted apron ramp area being of the adjustable aiming type shall be field adjusted or aimed at the Contractor's expense and to the satisfaction of the DEN Project Manager.
- C. All fixtures shall be field adjusted (verify final placement of fixtures also) in accordance with the manufacturer's aiming recommendations, and as indicated on the drawings and as required in the field. Include an allowance in the bid to cover all costs of aiming or adjusting these fixtures. Include an overtime allowance in the bid for aiming or adjusting exterior fixtures at night.
- D. Operational Readiness Test:
  - 1. Following completion of installation, aiming and startup, contractor shall demonstrate operation of all luminaires.
  - 2. Demonstration shall be performed at night, in the presence of the following attendees or their designee:
    - a. DEN Project Manager.
    - b. DEN Technical Maintenance.
    - c. DEN Ramp Tower manager.
    - d. FAA Tower representative.
  - 3. Demonstration shall include the following:
    - a. Operation of on/off lighting controls.
    - b. Fixture aiming verification.
    - c. Field observation of general illumination levels in the project area.
    - d. Glare evaluation at the project boundaries.
- E. Submit photometric report of light levels in all exterior areas to DEN Project Manager. All photometric readings shall be taken after a minimum of forty (40) hours burn-in of light fixtures.
- F. Contractor shall provide to the DEN Project Manager a Point by Point report showing the light level readings taken after luminaires have been properly aimed and the fixtures have had at least 50 hours of actual run time in the field. The grid spacing for

the readings shall be the same as the calculations submitted prior to start of construction.

- G. Training: Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice. Engage a factory-authorized service representative to assist Contractor and train DEN maintenance personnel to adjust, operate, and maintain all exterior lighting components, and luminaire lowering devices, if any.
1. Comply with Section 017515 “System Startup, testing and training” and Section 017900 “Demonstration and Training.”

#### PART 4 - MEASUREMENT

##### 4.1 METHOD OF MEASUREMENT

- A. High mast lights will be paid the Contract per type installed, complete and in-place, ready for operation, and accepted by the DEN Project Manager.

#### PART 5 - PAYMENT

##### 5.1 PAYMENT

- A. Payment shall be made at the Contract unit price per each for each item completed in accordance with the plans and specifications that is installed by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 26 56 50-5.1 Install High Mast Lighting on New Foundation – per each

Install High Mast Lighting shall include, foundation design, excavation, rebar, concrete, grounding, foundation, round tapered steel pole, remote driver enclosure, strut, fuses, conductors in pole, luminaires, conduit from enclosure to pole, provide a means to route comm cable from an above grade enclosure through the pole to interface with cameras, luminaire aiming, and all necessary incidentals to complete this item.

**END OF SECTION 265600**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 265650 – EXTERIOR LIGHTING - AIRSIDE**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## **SECTION 271300 - COMMUNICATIONS BACKBONE CABLING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Pathways.
  - 2. UTP cable.
  - 3. Single Mode Fiber Optic Cable 9/125 micrometer.
  - 4. Cable connecting hardware, patch panels, and cross-connects.
  - 5. Cabling identification products.
- B. Related Sections:
  - 1. Section 260553 "Identification for Electrical Systems" for identification of cable systems and components.
  - 2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### **1.3 DEFINITIONS**

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.
- G. UTP: Unshielded twisted pair.

#### 1.4 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- C. All work designed and constructed under this section shall comply with EIA/TIA 568, 569, 606 and relevant Building Industry Construction Service, Inc. (BICSI Standards).
- D. Designers are required to submit a complete set of plans and specifications for their projects to the DEN Telecommunications Department for review and approval. Designers are also required to meet with representatives from the DEN Telecommunications Department at one or more times during the course of design to work out specific interface details prior to the final submittal.
- E. Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete system of telecommunications pathways, spaces and cabling as required by the specifications and as shown on the Drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of work not mentioned or shown which are necessary for the successful operation of all telecommunications systems.
- F. Backbone copper and fiber cabling at DEN are assigned unique numbers that allow cabling pair and strand assignments to be managed by the DEN cable management system. Backbone (BB) and Inter-Building (IB) cable number assignments shall be coordinated with the DEN Technologies to ensure that numerical assignments do not conflict with existing cable designations used elsewhere in the airport.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: Provide complete product data for each element of cabling, and equipment proposed. Where a data sheet covers multiple items specifically mark items proposed for use on the Project.
  - 1. Include data substantiating that materials comply with requirements.

**B. Shop Drawings:**

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:
  - a. Cross-connects.
  - b. Patch panels.
  - c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

**1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Contractor, installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Maintenance Data: For splices and connectors to include in maintenance manuals.

**1.8 CLOSEOUT SUBMITTALS**

- A. Software and Firmware Operational Documentation:
  1. Complete test records for all cable tests.
  2. Diagrams indicating route, cable types, pair or strand count and cable ID numbers used in the Project.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".
  1. Provide complete as-built drawings for all IDF rooms, backbone conduit routes and tray routes indicating actual routing.

**1.9 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Patch-Panel Units: One (1) of each type.

2. Connecting Blocks: One (1) of each type.

#### 1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
  3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: An NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- F. Grounding: Comply with ANSI-J-STD-607-A.

#### 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
  2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
  3. Test each pair of UTP cable for open and short circuits.

**1.12 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Verify that field measurements are as shown on Drawings.
- C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required by field verification.

**1.13 COORDINATION**

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers, and with DEN Project Manager.
- B. **CONSTRUCTION WASTE MANAGEMENT**
  - 1. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. All metal conductors shall be copper.
- B. All building wire and cable shall be installed in approved raceways.
- C. Materials and Equipment: Acceptable to the authority having jurisdiction and suitable for the use intended, except where more stringent requirements are indicated as described herein.

**2.2 PATHWAYS**

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Reference Item L-110 for wire pathways, wireways, conduit and fittings.
- C. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
  - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
  - 2. Lacing bars, spools, J-hooks, and D-rings.

3. Straps and other devices.

D. Conduit and Boxes: Comply with requirements in Item L-110. Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

### 2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
13. or approved equal.

B. Description: 100-ohm, 24AWG, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Elevator cabling shall be gell filled with an overall polyethylene sheath.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
  - a. Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG.

### 2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.

5. Leviton Voice & Data Division.
  6. Molex Premise Networks; a division of Molex, Inc.
  7. Nordex/CDT; a subsidiary of Cable Design Technologies.
  8. Panduit Corp.
  9. Siemon Co. (The).
  10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
  11. or approved equal.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 5E or Category 6 . Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, 4-pair cables in 36-inch (**900-mm**) lengths; terminated with 8-position modular plug at each end. Termination sequence shall be EIA/TIA 568B.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
  2. Patch cords shall have color-coded boots for circuit identification.
- 2.5 OPTICAL FIBER CABLE
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek; a Nexans company.
  2. CommScope, Inc.
  3. Corning Cable Systems.
  4. General Cable Technologies Corporation.
  5. Mohawk; a division of Belden CDT.
  6. Nordex/CDT; a subsidiary of Cable Design Technologies.

7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
12. or approved equal.

B. Description: Single-mode, 125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ITU G.652.D.
2. Comply with ICEA S-87-640 for mechanical properties.
3. Comply with TIA/EIA-568-B.3 for performance specifications.
4. Comply with TIA/EIA-492AAAA-B for detailed specifications.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
  - a. General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP.
6. Conductive cable shall be steel armored type.
7. Maximum Attenuation: 1.8 dB/km at 850 nm.
8. Single Mode fiber shall be type SMF28E.
9. Minimum Modal Bandwidth: 160 MHz-km at 850 nm.

C. Jacket:

1. Jacket Color: Yellow for Single Mode Fiber.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

## 2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).
11. Superior Modular Products.
12. or approved equal.

- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered cable connectors. Connector type for all strands except those used for analog services shall be type LC. Strands used for analog services such as DEN TV and Distributed Antenna Systems shall be terminated with APC high return loss terminations.
  - 1. Number of Connectors per Field: One (1) for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords: Factory-made, single or dual-fiber cables in 36-inch (900-mm) incremental lengths.
- D. Cable Connecting Hardware:
  - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
  - 2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
  - 3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

## 2.7 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

## 2.8 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Reference Section 260553 "Identification for Electrical Systems" for identification of cable systems and components.

## 2.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**PART 3 - EXECUTION****3.1 GENERAL**

- A. All Work to be coordinated with and approved by DEN Telecommunications Department and DEN Project Manager.
- B. All Work to be coordinated with existing systems at DEN.

**3.2 WIRING METHODS**

- A. Verify pathways are open, continuous and clear of debris before installing cables.
- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

**3.3 INSTALLATION OF PATHWAYS**

- A. Drawings indicate general arrangement of pathways and fittings.
- B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Item L-110 for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- E. Install wire in raceway after all mechanical work likely to injure conductors has been completed.
- F. Completely and thoroughly swab raceway system before installing conductors.
- G. Conductors shall not be pulled in concrete encased conduits before concrete is placed.

**3.4 INSTALLATION OF CABLES**

- A. Comply with NECA 1.
- B. Provide protection for exposed cables where subject to damage.
- C. Use suitable cable fittings and connectors.
- D. All cable shall be racked and supported in manholes.
- E. Pulling winches and other necessary pulling equipment shall be of adequate capacity to ensure a continuous pull on the cable. Strain gages shall be used to monitor the

cable pulling tension.

- F. Cable and Wire pulling lubricants that are non-corrosive and harmless to hands and clothes shall be used. Lubricants shall be compatible with cable jackets and insulation.
- G. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
  2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  3. Install 110-style IDC termination hardware unless otherwise indicated.
  4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  5. Cables may not be spliced except at locations noted on the contract drawings.
  6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
  9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  11. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
  12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- H. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
  2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- I. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
  2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
  3. Exterior fiber cables shall be loose tube construction, with water blocking tape in all installations.
- J. Group connecting hardware for cables into separate logical fields.

**K. Separation from EMI Sources:**

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Transformers, 5 kVA and Larger: A minimum of 48 inches (1200 mm).

**3.5 GROUNDING**

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from

grounding bus bar to suitable electrical building ground.

- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling using backbone and inter-building cable numbers as assigned by DEN Technologies Premise Wiring & Communications.

1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

- B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- C. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
  - b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

- D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Torque conductor connections and terminations to manufacturer's recommended values. Provide torque report if requested by DEN Project Manager.
- C. Verify cables are colored coded and labeled according to contract documents.

- D. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- E. Perform tests and inspections.
- F. Tests and Inspections:
  - 1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-B.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  - 4. Optical Fiber Cable Tests:
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    - b. Link End-to-End Attenuation Tests - Single Mode:
      - 1) Perform an optical loss test of each strand using an optical power meter and calibrated light source at both 1310nm and 1550nm..
      - 2) Perform an Optical Time Domain Reflectometer test from both ends of each fiber strand at both 1310nm and 1550nm.
- G. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- H. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- I. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- J. Prepare test and inspection reports.

## **PART 4 - MEASUREMENT**

### **4.1 METHOD OF MEASUREMENT**

- A. Fiber optic cable will be paid the Contract per linear foot installed, complete and in-place, ready for operation, and accepted by the DEN Project Manager. The measurement for this item shall include additional quantities required for slack.

## **PART 5 - PAYMENT**

### **5.1 PAYMENT**

- A. Payment shall be made at the Contract unit price for fiber optic cable installed in ductbank, in-place by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, including splicing, terminations, testing, and incidentals necessary to complete this item.

Payment will be made under:

Item 27 13 00-5.1 Install Fiber Optic Cable, Single Mode, 12-Strand – per linear foot

END OF SECTION 271300

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
271300 – COMMUNICATIONS BACKBONE CABLING**

**DENVER INTERNATIONAL AIRPORT  
DS EAST TAXIWAY  
CONTRACT NO. 201737642-02**

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## SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. UTP cabling.
  - 2. Low-voltage control cabling.
  - 3. Control-circuit conductors.
  - 4. Identification products.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- F. RCDD: Registered Communications Distribution Designer.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data substantiating that materials comply with requirements.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Field quality-control reports.

**1.6 CLOSEOUT SUBMITTALS**

- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

**1.7 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Test cables upon receipt at Project site.
  - 1. Test each pair of UTP cable for open and short circuits.

**1.9 FIELD CONDITIONS**

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
  - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

**1.10 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **2.2 UTP CABLE**

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. ADC.
  - 2. AMP Netconnect; a brand of Tyco Electronics Corporation.
  - 3. Belden Inc.
  - 4. Berk-Tek; a Nexans company.
  - 5. CommScope, Inc.
  - 6. Draka Cableteq USA.
  - 7. Genesis Cable Products; Honeywell International, Inc.
  - 8. Mohawk; a division of Belden Networking, Inc.
  - 9. Superior Essex Inc.
  - 10. SYSTIMAX Solutions; a CommScope, Inc. brand.
  - 11. 3M; Communication Markets Division.
  - 12. or approved equal.
- B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties.
  - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
  - 3. Comply with TIA/EIA-568-B.2, Category 5e Category 6.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG.
    - b. Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, complying with UL 1666.

**2.3 UTP CABLE HARDWARE**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC.
  2. American Technology Systems Industries, Inc.
  3. AMP Netconnect; a brand of Tyco Electronics Corporation.
  4. Belden Inc.
  5. Dynacom Inc.
  6. Hubbell Incorporated; Hubbell Premise Wiring.
  7. Leviton Commercial Networks Division.
  8. Molex Premise Networks; a division of Molex, Inc.
  9. Panduit Corp.
  10. Siemon.
  11. or approved equal.
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: 110-style for Category 5e 110-style for Category 6 66-style for Category 5e. Provide blocks for the number of cables terminated on the block, plus percent spare. Integral with connector bodies, including plugs and jacks where indicated.

**2.4 LOW-VOLTAGE CONTROL CABLE**

- A. Paired Cable: NFPA 70, Type CMG.
1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with UL 1581.

**2.5 IDENTIFICATION PRODUCTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Worldwide, Inc.
  2. HellermannTyton North America.
  3. Kroy LLC.
  4. Panduit Corp.
  5. or approved equal.

- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All power, control, data, communication and signal wire or cable shall be installed in an approved raceway.
- B. Completely and thoroughly swab raceway system before installing conductors.
- C. Conductors shall not be pulled in concrete encased conduits before concrete is placed.
- D. All cable shall be racked and supported in manholes.
- E. Pulling winches and other necessary pulling equipment shall be of adequate capacity to ensure a continuous pull on the cable. Strain gages shall be used to monitor the cable pulling tension.
- F. Cable and Wire pulling lubricants that are non-corrosive and harmless to hands and clothes shall be used. Lubricants shall be compatible with cable jackets and insulation.
- G. Splice only in accessible junction and outlet boxes

### 3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

### 3.3 WIRING METHOD

- A. Install wiring in metal pathways and wireways.
  - 1. Minimum conduit size shall be 1 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- C. Wiring within Enclosures:
  - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  - 2. Install lacing bars and distribution spools.
  - 3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
  - 4. Install conductors parallel with or at right angles to sides and back of enclosure.
  - 5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
  - 6. Mark each terminal according to system's wiring diagrams.
  - 7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

### 3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
1. Comply with TIA/EIA-568-B.2.
  2. Install 110-style IDC termination hardware unless otherwise indicated.
  3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- E. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
  3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  5. Separation between Cables and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

### 3.5 CONNECTIONS

- A. Comply with requirements in Section 282300 "Video Surveillance" for connecting, terminating, and identifying wires and cables.

### 3.6 GROUNDING

- A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

#### **PART 4 - MEASUREMENT**

##### 4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### 5.1 PAYMENT

- A. Conductors and Cables for Electronic Safety and Security shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 280513**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
280513 – CONDUCTORS AND CABLES FOR ELECTRONIC  
SAFETY AND SECURITY**

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**DENVER INTERNATIONAL AIRPORT  
DS EAST TAXIWAY  
CONTRACT NO. 201737642-02**

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## **SECTION 282300 - VIDEO SURVEILLANCE**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Contractor shall provide all skilled labor, material, and equipment for the complete installation of the Video Surveillance System additions and modifications as shown on the drawings and specified herein. The Video Surveillance System on this Project is an extension of the existing Genetec Omnicast 4.8 system. The Contractor shall acquire from the manufacturer the installation practices as published by the Manufacturer.

Work includes:

1. IP Cameras.
2. Cabling.

The Contractor shall be responsible to provide a complete installation in compliance with DEN requirements, Denver Building Codes, and Denver Fire Prevention Bureau requirements. DEN will perform all required headend programming. Testing shall be performed jointly by the Contractor, DEN and the Premise Wiring and Communications (PWCS) Contractor. Refer to the Responsibility Matrix detailed in the Contract Drawings for further clarification regarding the delineation in the scope of work. Coordinate all work through the DEN Project Manager.

- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
  1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
  2. Wiring Diagrams: For power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

A. Field quality-control reports.  
Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Hard copies of manufacturer's specification sheets and PDF files on CD-ROM of the hard-copy submittal.
  2. Include letter from manufacturer's representative stating that system is operational.
- B. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name, and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1. Contractor shall maintain on site accurate as-built drawings indicating dimensioned locations of constructed raceway, box, and device locations. Any modifications to work depicted on the Engineered shop drawings shall be noted. Documents shall be updated daily and shall at all times be available for DEN review.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Comply with NECA 1.

Comply with NFPA 70.

Contractor shall be fully responsible for daily quality control of all system installation, coordination with trades, and coordination with DEN Security and DEN Technical Maintenance.

Installer Qualifications: Company with factory-trained and certified personnel specializing in digital closed circuit television systems with three (3) years' documented experience as a digital

CCTV installing contractor.

## 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 3R enclosures.
  2. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. All products:
1. Store in temperature-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C).
  2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
  3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Minimum three (3) years from date of Substantial Completion.
  2. Warranty service shall be provided by a trained specialist of the equipment manufacturer, who shall be based in a fully staffed, fully stocked (replacement parts and test equipment) office, located within 50 miles of the site.

## 1.11 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to

satisfy the requirements of that Section.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. All equipment and materials used shall be new, standard components, regularly manufactured, regularly utilized in the manufacturer's system.

All systems and components shall have been thoroughly tested and proven in actual use.

### **2.2 CAMERAS**

A. General Requirements

1. Power: POE preferred. Refer to specified models for individual requirements and drawings for additional information. For POE+ and UPOE coordinate with engineer and DEN project manager. Contractor shall verify voltage requirements for all cameras, prior to shop drawing submittal, based on the camera power requirements as well as directions on the plans and schedules. No additional compensation will be provided due to failure of compliance with requirements.
2. Video: H.264 required, motion JPEG capable.
3. Network:
  - a. IPv4/v6, HTTP, HTTPS, SSL/TLS, SMTP, SNMP
  - b. Multi-level password, IP filter, HTTPS encryption, IEEE 802.1x
4. Audio – Not required at all locations. Refer to specified models for standard and drawings for additional information.
5. Environment – Location specific
6. Mounting – Surface, wall, ceiling, corner, parapet, or other as shown on drawings. Coordinate camera mounting with the architectural ceiling plans, sections and elevations. Provide all mounting hardware including trim and flanges to complete the installation.

- B. Approved cameras: As manufactured by AXIS Communications or approved equal. See below for procedure required to submit product for approval as equal. The model number indicates the type of camera with its minimum requirements and does not include accessories required or environment intended (indoor, outdoor, industrial, etc.) Standard cameras used at DEN are as follows.

1. Fixed: P3265-LVE
2. PTZ: Q6075 (Interior) Q6075-E (Exterior)
3. 180 Degree: P3807-PVE
4. 360 Degree: M3057-PLVE MK II
5. 360 Degree with Audio: M3077-PLVE

- C. Contractor shall submit shop drawings for the cameras indicating all required accessories as shown on the drawings and in the specifications. Whether specified by the catalog numbers or not, the contractor shall provide all components, hardware and related items to provide a complete and operational system to meet the requirements as specified in the drawings and specifications.

A product from a manufacturer not listed may be submitted for approval during the shop drawing phase. Requests for substitutions will not be approved after the shop drawing phase. The product must be equal in physical attributes, and meet or exceed quality and performance requirements, without exceeding the capabilities of existing infrastructure. The A/E's determination for the approval shall govern. Provide complete detail of the proposed equal camera with a detailed comparison to the specified camera including any additional information requested by the A/E. Prototype products shall not be submitted for approval as equal to specified products.

### 2.3 CABLES

- A. General Cable Requirements: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

Cable conductors shall be stranded copper. Provide cable with chrome gray PVC jacket and UL-CMP listing.

Approved Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Belden, West Penn.
2. Approved equal.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. The Contractor shall coordinate and arrange a pre work meeting with the DEN Project Manager, DEN Project Inspectors, DEN Security, and DEN Technical Maintenance one (1) week in advance of the beginning of any work. The DEN Project Manager shall review the Contractor's construction demolition, phasing, implementation, and testing plans and schedule.
- B. Meeting Notes: Meeting notes shall be accurately recorded by the DEN Project Manager and distributed within five (5) working days after the meeting.

### 3.2 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

Examine roughing-in for LAN, WAN, and IP network before device installation.

Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 GENERAL

- A. Installation shall be supervised and tested by a representative of the manufacturer of the system equipment. The Work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this Work.

Raceways: Raceways shall be installed in accordance with Item L-110.

Wire and Cable: All wiring and cable shall be installed in metal raceways or within equipment. Splices shall not be allowed. Conductors within equipment enclosures shall be carefully cabled and laced. Individual cables shall be tagged with markers indicating circuit number and type. Markers shall be used and numbered according to Cabling Schedule with cable numbers on all conductors at each outlet or pull box at each equipment enclosure.

### 3.4 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

### 3.5 GROUNDING

- A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

Bond shields and drain conductors to ground at only one point in each circuit.

Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### 3.6 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras level and plumb.

Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.

Install power supplies and other auxiliary components unless otherwise indicated.

Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."

### 3.7 INTERFACE WITH OTHER SYSTEMS

- A. Interface programming of closed circuit television system with computerized card access system shall be by DEN Technical Maintenance and/or DEN Security. Coordinate all Work through DEN Project Manager.

### 3.8 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-A.
- B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

### 3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare

video-surveillance equipment for acceptance and operational testing as follows:

- a. Verify operation of auto-iris lenses.
  - b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
  - c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
  - d. Set and name all preset positions; consult Owner's personnel.
  - e. Set sensitivity of motion detection.
  - f. Connect and verify responses to alarms.
  - g. Verify operation of control-station equipment.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
  4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
  5. A representative of the installing Contractor shall submit a written report of the findings to the DEN Project Manager. Representative shall be factory trained and certified and have at least three (3) years' experience installing access control systems.
    - a. Report shall consist of a complete listing of every device and feature, the date it was tested and by whom, the results, and the date retested (if failure occurred during any previous tests). The final test reports shall indicate that every device tested successfully. Submit two typed copies of the test reports in a neatly bound folder to the DEN Project Manager for approval. Failure to comply will result in a delay of final testing and acceptance.
  6. Design engineer and DEN Project Manager will witness all field tests.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports.

### 3.10 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.

## PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Cameras will be paid the Contract per type installed, complete and in-place, ready for operation, and accepted by the DEN Project Manager.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. Payment shall be made at the Contract unit price per each for each item completed in accordance with the plans and specifications, in-place by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, including calibration, aiming, telecom enclosure, equipment in the telecom enclosure, patch panels, patch cables, minipower center, cable feeding minipower center, cable and conduit from minipower center to telecom enclosure, UTP cable between telecom enclosure and cameras, terminations, testing and incidentals necessary to complete this item.

Payment will be made under:

- Item 28 23 00-5.1 Install PTZ and Fixed Lens Camera on High Mast Light Pole – per each

END OF SECTION 282300

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 282300 – VIDEO SURVEILLANCE**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**EXHIBIT J**

**CONTRACT DRAWINGS**

**Denver International Airport  
Contract No. 202366450**

**Flatiron Constructors, INC.  
Taxiway DS East and Deicing Pad**

**Incorporated by Reference as found in File #20230038  
at the Denver Office of the Clerk and Recorder**

**EXHIBIT K**

**INVITATION FOR BID AND CONTRACTOR'S  
RESPONSE TO INVITATION FOR BID**

**Denver International Airport  
Contract No. 202366450**

**Flatiron Constructors, INC.  
Taxiway DS East and Deicing Pad**

**Incorporated by Reference as found in File #20230039  
at the Denver Office of the Clerk and Recorder**

## CONTRACT FOR CONSTRUCTION

**THIS CONTRACT FOR CONSTRUCTION (“Contract”)** is made and entered into as of the date stated on the City’s signature page below (the **“Effective Date”**) by and between the **CITY AND COUNTY OF DENVER**, a municipal corporation of the State of Colorado acting on behalf of its Department of Aviation (the **“City”**), and **FLATIRON CONSTRUCTORS, INC.**, a Delaware corporation authorized to do business in the State of Colorado (**“Contractor”**) (collectively the **“Parties”**).

### WITNESSETH

**WHEREAS**, the City, for at least three (3) consecutive days, advertised that proposals would be received for furnishing all labor, tools, supplies, equipment, materials and everything necessary and required for the construction and installation of the work under **Invitation for Bid (Construction) No. 202366450, Taxiway DS East and Deicing Pad** (the **“Project”**) at Denver International Airport (**“DEN”**); and

**WHEREAS**, bids in response to said advertisement have been received by the Chief Executive Officer of Denver International Airport (the **“CEO”**), who has recommended that a contract for the work be made and entered into with Contractor, which was the lowest, responsive, qualified bidder; and

**WHEREAS**, Contractor is qualified, willing, and able to perform the Project in accordance with its proposal and the Contract Documents defined below;

**NOW, THEREFORE**, for and in consideration of the compensation to be paid by the City to Contractor and the other terms and conditions of this Contract, the Parties agree as follows:

#### 1. CONTRACT DOCUMENTS:

It is agreed by the Parties that the instruments, drawings, and documents described below and whether attached to and bound with this Contract or not (the **“Contract Documents”**), are incorporated into the Contract by this reference, and are as fully a part of this Contract as if they were set out here verbatim and in full:

- Contract
- Notice to Proceed
- Form of Final Receipt
- Building Information Modeling (**“BIM”**) if applicable
- Change Directives
- Change Orders
- Exhibit A Federal Appendices
- Exhibit B Equal Employment Opportunity Provisions
- Exhibit C Insurance Requirements
- Exhibit D Prevailing Wage Schedules
- Exhibit E Special Conditions

- Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the “Yellow Book”) (“General Conditions”) (Table of Contents attached as Exhibit F)
- Exhibit G Performance Bond
- Exhibit H Payment Bond
- Exhibit I Technical Specifications
- Exhibit J Contract Drawings
- Exhibit K Invitation for Bids and Contractor’s Response to Invitation for Bids

In the event of an irreconcilable conflict between a provision of Section 1 through 31 of this Contract document and any other provisions of the Contract Documents such that it is impossible to give effect to both, the order of precedence to determine which document shall control to resolve such conflict is as follows, in descending order:

1. Exhibit A Federal Appendices
2. Contract
3. Change Directives
4. Change Orders
5. Exhibit B Equal Employment Opportunity Provisions
6. Exhibit E Special Conditions
7. Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the “Yellow Book” or “General Conditions”) (Table of Contents attached as Exhibit F)
8. Exhibit C Insurance Requirements
9. Exhibit D Prevailing Wage Schedules
10. Exhibit I Technical Specifications
11. Exhibit J Contract Drawings
12. Exhibit K Invitation for Bids and Contractor’s Response to Invitation for Bids
13. Exhibit G Performance Bond
14. Exhibit H Payment Bond
15. Notice to Proceed
16. Form of Final Receipt
17. Building Information Modeling (“BIM”) if applicable

The remaining order of precedence is established in General Conditions Title 4.

## 2. SCOPE OF WORK:

Contractor shall furnish all labor and tools, supplies, equipment, superintendence, materials, and everything necessary for and required to do, perform, and complete all of the work described, drawn, set forth, shown, and included in the Contract Documents (the “Work”).

## 3. TERM OF CONTRACT:

The Senior Vice President of Aviation – Airport Infrastructure Management (the “SVP-AIM”) will issue a written notice to proceed to Contractor (the “Notice to Proceed”), and

Contractor shall begin performing the Work required under this Contract within ten (10) days of such Notice to Proceed (the “**Commencement Date**”). Contractor shall fully complete the Work in its entirety within **Four Hundred Eleven (411)** consecutive calendar days from the date of the Notice to Proceed (“**Contract Time**”). Contractor is not authorized to commence work prior to its receipt of the Notice to Proceed.

**4. TERMS OF PAYMENT:**

The City agrees to pay Contractor for the performance and completion of all of the Work as required by the Contract Documents, and Contractor agrees to accept as its full and only compensation therefor, a total amount of **Sixty Million Four Hundred Sixty-One Thousand Seven Hundred and Seventy Dollars and Five Cents (\$60,461,770.05)** (the “**Maximum Contract Amount**”). In no event will the City’s liability exceed the Maximum Contract Amount, as adjusted by duly authorized Change Orders in accordance with this Contract. The Parties specifically agree that any performance by Contractor hereunder shall not subject the City to any cost, charge, or fee not specified above.

**5. VERIFIED STATEMENT OF CLAIMS:**

Colorado Revised Statutes § 38-26-107 (“**C.R.S.**”) requires that, in the event any person or company files a verified statement of amounts due and unpaid in connection with a claim for labor and materials supplied on this project, the City shall withhold from payments to Contractor sufficient funds to insure the payment of any such claims. Should the City be made a party to any lawsuit to enforce such unpaid claims or any lawsuit arising out of or relating to such withheld funds, Contractor agrees to pay to the City its costs and a reasonable attorney’s fee incurred in any such lawsuit. Because the City Attorney Staff does not bill the City for legal services on an hourly basis, Contractor agrees a reasonable fee shall be computed at the rate of two hundred dollars and no cents (\$200.00) per hour of City Attorney time.

**6. DISPUTES:**

All disputes arising under or related to this Contract shall be resolved by administrative hearing under the procedures described in **Exhibit F**, as modified by **Exhibit E**, if any, and the Denver Revised Municipal Code § 5-17 (“**D.R.M.C.**”) and all related rules and procedures, including but not limited to DEN Rule 250. The determination resulting from said administrative hearing shall be final, subject only to Contractor’s right to appeal the determination under Colorado Rule of Civil Procedure, Rule 106.

**7. DEFENSE AND INDEMNIFICATION:**

**A.** To the fullest extent permitted by law, Contractor hereby agrees to defend, indemnify, reimburse and hold harmless City, its appointed and elected officials, agents and employees for, from and against all liabilities, claims, judgments, suits or demands for damages to persons or property arising out of, resulting from, or related to the work performed under this Contract that are due to the negligence or fault of the Contractor or the Contractor’s agents, representatives, subcontractors, or suppliers (“**Claims**”). This indemnity shall be interpreted in the broadest possible manner consistent with the applicable law to indemnify the City.

**B.** Contractor's duty to defend and indemnify City shall arise at the time written notice of the Claim is first provided to City regardless of whether suit has been filed and even if Contractor is not named as a Defendant.

**C.** Contractor will defend any and all Claims which may be brought or threatened against City and will pay on behalf of City any expenses incurred by reason of such Claims including, but not limited to, court costs and attorney fees incurred in defending and investigating such Claims or seeking to enforce this indemnity obligation, including but not limited to time expended by the City Attorney Staff, whose costs shall be computed at the rate specified in Section 5 . Such payments on behalf of City shall be in addition to any other legal remedies available to City and shall not be considered City's exclusive remedy.

**D.** Insurance coverage requirements specified in this Contract shall in no way lessen or limit the liability of the Contractor under the terms of this indemnification obligation. The Contractor shall obtain, at its own expense, any additional insurance that it deems necessary for the City's protection.

**E.** This defense and indemnification obligation shall survive the expiration or termination of this Contract.

**8. WAIVER OF C.R.S. § 13-20-801, et seq.:**

Notwithstanding any other provision of this Contract, Contractor specifically waives all of the provisions of C.R.S. §§ 13-20-801 *et seq.* as they may relate to Contractor's performance.

**9. LIQUIDATED DAMAGES:**

If Contractor fails to achieve Substantial Completion of the Work within the Contract Time or fails to substantially complete the Work described in the Scope of Work within the time set forth in the Special Conditions, the City will suffer substantial damages, which damages would be difficult to accurately determine. The Parties hereto have considered the possible elements of damages and have agreed that the amount of liquidated damages for Contractor's failure to substantially complete the work within the Contract Time or to substantially complete the work described in Milestone Areas within the time set forth in the Special Conditions shall be as provided in the Special Conditions. If Contractor shall fail to pay such liquidated damages promptly upon demand therefor, the Surety on its Performance Bond and Payment Bond shall pay such damages. Also, the City may withhold all, or any part of, such liquidated damages from any payment due to Contractor. Additional provisions relating to liquidated damages are set forth in the Construction Contract General Conditions and Special Conditions.

**10. INSURANCE REQUIREMENTS:**

**A.** Contractor shall obtain and keep in force all of the minimum insurance coverage forms and amounts set forth in **Exhibit C** ("**Insurance Requirements**") during the entire Term of this Agreement, including any extensions of the Agreement or other extended period stipulations stated in **Exhibit C**. All certificates of insurance must be received and accepted by the City before any airport access or work commences.

**B.** Contractor shall ensure and document that all subcontractors performing services or providing goods hereunder procure and maintain insurance coverage that is appropriate to the primary business risks for their respective scopes of performance. At minimum, such insurance must conform to all applicable requirements of DEN Rules and Regulations Part 230 and all other applicable laws and regulations.

**C.** The City in no way warrants or represents the minimum limits contained herein are sufficient to protect Contractor from liabilities arising out of the performance of the terms and conditions of this Contract by Contractor, its agents, representatives, employees, or subcontractors. Contractor shall assess its own risks and maintain higher limits and/or broader coverage as it deems appropriate and/or prudent. Contractor is not relieved of any liability or other obligations assumed or undertaken pursuant to this Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration, or types.

**D.** In no event shall the City be liable for any of the following: (i) business interruption or other consequential damages sustained by Contractor; (ii) damage, theft, or destruction of Contractor's inventory, or property of any kind; or (iii) damage, theft, or destruction of an automobile, whether or not insured.

**E.** The Parties understand and agree that the City, its elected and appointed officials, employees, agents and volunteers are relying on, and do not waive or intend to waive by any provisions of this Contract, the monetary limitations and any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, C.R.S. §§ 24-10-101, *et seq.*, or otherwise available to the City, its elected and appointed officials, employees, agents and volunteers.

## **11. CONTRACT BINDING:**

It is agreed that this Contract shall be binding on and inure to the benefit of the Parties hereto, their heirs, executors, administrators, assigns, and successors.

## **12. SEVERABILITY:**

If any part, portion, or provision of this Contract shall be found or declared null, void, or unenforceable for any reason whatsoever by any court of competent jurisdiction or any governmental agency having authority thereover, only such part, portion, or provision shall be affected thereby and all other parts, portions, and provisions of this Contract shall remain in full force and effect.

## **13. ASSIGNMENT:**

Contractor shall not assign, pledge or transfer its duties, obligations, and rights under this Contract, in whole or in part, without first obtaining the written consent of the CEO or their authorized representative. Any attempt by Contractor to assign or transfer its rights hereunder without such prior written consent shall, at the option of the CEO or their authorized representative, automatically terminate this Contract and all rights of Contractor hereunder.

**14. APPROPRIATIONS:**

Payment will be in accordance with the provisions of the Contract Documents, including Title 9 of the General Conditions, and will be made solely and exclusively from funds appropriated or otherwise lawfully made available for the purposes of this Contract from the Airport System Funds. The City has no obligation to make payments from any other fund or source or to make additional appropriations or allocations to such fund to satisfy such costs or other obligations.

**15. APPROVALS:**

In the event this Contract calls for the payment by the City of Five Million Dollars and no cents (\$5,000,000.00) or more, approval by the Denver City Council, acting by Resolution in accordance with Section 3.2.6 of the Charter of the City and County of Denver, is and shall be an express condition precedent to the lawful and binding execution and performance of this Contract.

**16. JOINT VENTURE:**

If Contractor is a Joint Venture, the partners to the Joint Venture shall be jointly and severally liable to the City for the performance of all duties and obligations of Contractor which are set forth in the Contract.

**17. NO DISCRIMINATION IN EMPLOYMENT:**

In connection with the performance of work under the Agreement, the Contractor may not refuse to hire, discharge, promote, demote, or discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, ethnicity, citizenship, immigration status, gender, age, sexual orientation, gender identity, gender expression, marital status, source of income, military status, protective hairstyle, or disability. The Contractor shall insert the foregoing provision in all subcontracts.

**18. COORDINATION OF SERVICES:**

Contractor agrees to perform its work under this Contract in accordance with the operational requirements of DEN, and all work and movement of personnel or equipment on areas included within the DEN site shall be subject to the regulations and restrictions established by the City or its authorized agents.

**19. COMPLIANCE WITH ALL LAWS AND REGULATIONS:**

**A.** Contractor and its subcontractor(s) shall perform all work under this Contract in compliance with all existing and future applicable laws, rules, regulations, and codes of the United States, and the State of Colorado and with the City Charter, ordinances, Executive Orders, and rules and regulations of the City.

**B.** Contractor shall perform all work in compliance with Executive Order 123 regarding Sustainability as may be directed by the City, including the requirement that all new City buildings and major renovations will be certified to the applicable LEED Gold Certification, with the goal of achieving LEED Platinum where economically feasible. Contractor also shall comply with all applicable DEN design and construction standards, including the DEN Design Standards Manuals, which are incorporated herein by reference. Current versions can be found at: <https://business.flydenver.com/bizops/bizRequirements.asp>.

**20. PREVAILING WAGE REQUIREMENTS:**

**A.** In addition to the Davis-Bacon Requirements contained in *Exhibit A*, Contractor shall comply with, and agrees to be bound by, all requirements, conditions and determinations of the City regarding the Payment of Prevailing Wages Ordinance, D.R.M.C. §§20-76 through 20-79, including, but not limited to, the requirement that every covered worker working on a City-owned or leased building or on City-owned land shall be paid no less than the prevailing wages and fringe benefits in effect on the date the bid or request for proposal was advertised. In the event a request for bids, or a request for proposal, was not advertised, Contractor shall pay every covered worker no less than the prevailing wages and fringe benefits in effect on the date funds for the Contract were encumbered.

Date bid or proposal issuance was advertised: January 27, 2023

If contract opportunity was not advertised, date of written encumbrance: N/A

**B.** Prevailing wage and fringe rates will adjust on the yearly anniversary of the actual date of bid or proposal issuance, if applicable, or the date of the written encumbrance if no bid/proposal issuance date is applicable. Unless expressly provided for in this Contract, Contractor will receive no additional compensation for increases in prevailing wages or fringe rates.

**C.** Contractor shall provide the Auditor of the City and County of Denver with a list of all subcontractors providing any services under the Contract.

**D.** Contractor shall provide the Auditor with electronically-certified payroll records for all covered workers employed under the Contract in a manner specified by the Auditor.

**E.** Contractor shall prominently post at the work site the current prevailing wage and fringe rates. The posting must inform workers that any complaints regarding the payment of prevailing wages or fringe benefits may be submitted to the Denver Auditor by calling 720-913-5000 or emailing [auditor@denvergov.org](mailto:auditor@denvergov.org).

**F.** If Contractor fails to pay workers as required by the Prevailing Wage Ordinance, Contractor will not be paid until documentation of payment satisfactory to the Auditor has been provided. The Auditor may enforce the Prevailing Wage Ordinance in a manner provided by law, including the Prevailing Wage Ordinance. The City also may, by written notice, suspend or terminate work if Contractor fails to pay required wages and fringe rates.

**21. CITY PROMPT PAYMENT:**

**A.** The City will make monthly progress payments to the Contractor for all services performed under this Contract based upon the Contractor’s monthly invoices or shall make payments as otherwise provided in this Agreement. The City’s Prompt Payment Ordinance, D.R.M.C. §§ 20-107 to 20-118, applies to invoicing and payment under this Contract.

**B.** Final Payment to the Contractor shall not be made until after the Project is accepted, and all certificates of completion, record drawings, reproducible copies, and other deliverables are delivered to the City, and the Contract is otherwise fully performed by the Contractor. The City may, at the discretion of the SVP, withhold reasonable amounts from billing and the entirety of the final payment until all such requirements are performed to the satisfaction of the SVP.

**C. Prompt Pay of DBE Subcontractors.** For contracts with federal funds to which Title 49 CFR §26.29 applies, Contractor is required to comply with the Prompt Payment provisions under Title 49 CFR §26.29, with regard to payments by Contractor to DBE subcontractors. Contractor shall make payment by no later than thirty (30) days from receipt by Contractor of the subcontractor’s invoice.

**22. OWNERSHIP AND DELIVERABLES:**

Upon payment to Contractor, all records, data, deliverables, and any other work product prepared by Contractor or any custom development work performed by Contractor for the purpose of performing this Contract on or before the day of the payment, whether a periodic or final payment, shall become the sole property of the City. Upon request by the City, or based on any schedule agreed to by Contractor and the City, Contractor shall provide the City with copies of the data/files that have been uploaded to any database maintained by or on behalf of Contractor or otherwise saved or maintained by Contractor as part of the services provided to the City under this Contract. All such data/files shall be provided to the City electronically in a format agreed to by the Parties. Contractor also agrees to allow the City to review any of the procedures Contractor uses in performing any work or other obligations under this Contract, and to make available for inspection any and all notes, documents, materials, and devices used in the preparation for or performance of any of the scope of work, for up to six (6) years after termination of this Contract. Upon written request from the City, Contractor shall deliver any information requested pursuant to this Section within ten (10) business days in the event a schedule or otherwise agreed-upon timeframe does not exist.

**23. COLORADO OPEN RECORDS ACT:**

**A.** Contractor acknowledges that the City is subject to the provisions of the Colorado Open Records Act (“**CORA**”), C.R.S. §§ 24-72-201 *et seq.*, and Contractor agrees that it will fully cooperate with the City in the event of a request or lawsuit arising under such act for the disclosure of any materials or information which Contractor asserts is confidential or otherwise exempt from disclosure. Any other provision of this Contract notwithstanding, all materials, records, and information provided by Contractor to the City shall be considered confidential by the City only to the extent provided in CORA, and Contractor agrees that any disclosure of information by the

City consistent with the provisions of CORA shall result in no liability of the City.

**B.** In the event of a request to the City for disclosure of such information, time and circumstances permitting, the City will make a good faith effort to advise Contractor of such request in order to give Contractor the opportunity to object to the disclosure of any material Contractor may consider confidential, proprietary, or otherwise exempt from disclosure. In the event Contractor objects to disclosure, the City, in its sole and absolute discretion, may file an application to the Denver District Court for a determination of whether disclosure is required or exempted. In the event a lawsuit to compel disclosure is filed, the City may tender all such material to the court for judicial determination of the issue of disclosure. In both situations, Contractor agrees it will either waive any claim of privilege or confidentiality or intervene in such legal process to protect materials Contractor does not wish disclosed. Contractor agrees to defend, indemnify, and hold harmless the City, its officers, agents, and employees from any claim, damages, expense, loss, or costs arising out of Contractor's objection to disclosure, including prompt reimbursement to the City of all reasonable attorney's fees, costs, and damages the City may incur directly or may be ordered to pay by such court, including but not limited to time expended by the City Attorney Staff, whose costs shall be computed at the rate specified in Section 5.

#### **24. EXAMINATION OF RECORDS AND AUDITS:**

**A.** Any authorized agent of the City, including the City Auditor or his or her representative, has the right to access, and the right to examine, copy and retain copies, at City's election in paper or electronic form, any pertinent books, documents, papers and records related to Contractor's performance pursuant to this Contract, provision of any goods or services to the City, and any other transactions related to this Contract. Contractor shall cooperate with City representatives and City representatives shall be granted access to the foregoing documents and information during reasonable business hours and until the latter of six (6) years after the final payment under the Contract or expiration of the applicable statute of limitations. When conducting an audit of this Contract, the City Auditor shall be subject to government auditing standards issued by the United States Government Accountability Office by the Comptroller General of the United States, including with respect to disclosure of information acquired during the course of an audit. No examination of records and audits pursuant to this paragraph shall require Contractor to make disclosures in violation of state or federal privacy laws. Contractor shall at all times comply with D.R.M.C. 20-276.

**B.** Additionally, Contractor agrees until the expiration of six (6) years after the final payment under this Contract, any duly authorized representative of the City, including the CEO or their representative, shall have the right to examine any pertinent books, documents, papers and records of Contractor related to Contractor's performance of this Contract, including communications or correspondence related to Contractor's performance, without regard to whether the work was paid for in whole or in part with federal funds or was otherwise related to a federal grant program.

**C.** In the event the City receives federal funds to be used toward the services performed under this Contract, the Federal Aviation Administration ("FAA"), the Comptroller

General of the United States and any other duly authorized representatives shall have access to any books, documents, papers and records of Contractor which are directly pertinent to a specific grant program for the purpose of making audit, examination, excerpts and transcriptions. Contractor further agrees that such records will contain information concerning the hours and specific services performed along with the applicable federal project number.

**25. MINIMUM WAGE REQUIREMENTS:**

To the extent required by law, Contractor shall comply with and agrees to be bound by all requirements, conditions, and City determinations regarding the City's Minimum Wage Ordinance, D.R.M.C. §§ 20-82 through 20-84, including, but not limited to, the requirement that every covered worker shall be paid no less than the City Minimum Wage in accordance with the City's Minimum Wage Ordinance. By executing this Contract, Contractor expressly acknowledges that Contractor is aware of the requirements of the City's Minimum Wage Ordinance and that any failure by Contractor, or any other individual or entity acting subject to this Contract, to strictly comply with the foregoing D.R.M.C. Sections shall result in the penalties and other remedies authorized therein.

**26. COMPLIANCE WITH DISADVANTAGED BUSINESS ENTERPRISE REQUIREMENTS:**

**A.** Department of Transportation (DOT), 49 C.F.R. Part 26 ("Part 26") applies to this Project and will be incorporated into any contract entered into by the City and contained in the City and County of Denver Bid Documents. The contractor, sub-recipient, or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate as further provided in Exhibit A. Consequently, Contractor must fully comply with the DBE requirements of Part 26 in bidding and performing hereunder.

**A.** Part 26 provides for the adoption of a good faith goals program, to be administered by the Division of Small Business Opportunity (DSBO). As such, each bidder must comply with the terms and conditions of the Part 26 in making its bid and, if awarded the Contract, in performing all Work thereunder. A bidder's failure to comply with Part 26, any Rules or Regulations promulgated pursuant thereto, or any additional requirements contained herein may render a bid non-responsive and may constitute cause for rejection.

**B.** In accordance with the requirements of the Part 26, the Contractor is committed to, at a minimum, meet the participation goal of **Twenty Four and One Tenth Percent (24.10%)** established for this Project utilizing properly certified DBE subcontractors and suppliers.

**27. SENSITIVE SECURITY INFORMATION:**

Contractor acknowledges that, in the course of performing its work under this Contract, Contractor may be given access to Sensitive Security Information (“SSI”), as material is described in the Code of Federal Regulations, 49 C.F.R. Part 1520. Contractor specifically agrees to comply with all requirements of the applicable federal regulations, including but not limited to, 49 C.F.R. Parts 15 and 1520. Contractor understands any questions it may have regarding its obligations with respect to SSI must be referred to DEN’s Security Office.

**28. DEN SECURITY:**

**A.** Contractor, its officers, authorized officials, employees, agents, subcontractors, and those under its control, shall comply with safety, operational, or security measures required of Contractor or the City by the FAA or TSA. If Contractor, its officers, authorized officials, employees, agents, subcontractors or those under its control, fail or refuse to comply with said measures and such non-compliance results in a monetary penalty being assessed against the City, then, in addition to any other remedies available to the City, Contractor shall fully reimburse the City any fines or penalties levied against the City, and any attorney fees or related costs paid by the City as a result of any such violation. Contractor must pay this amount within fifteen (15) days from the date of the invoice or written notice. Any fines and fees assessed by the FAA or TSA against the City due to the actions of Contractor and/or its agents will be deducted directly from the invoice for that billing period.

**B.** Contractor is responsible for compliance with Airport Security regulations and 49 C.F.R. Parts 1542 (Airport Security) and 14 C.R.F. Parts 139 (Airport Certification and Operations). Any and all violations pertaining to Parts 1542 and 139 resulting in a fine will be passed on to and borne by Contractor. The fee/fine will be deducted from the invoice at time of billing.

**29. FEDERAL RIGHTS:**

**A.** This Contract is subject and subordinate to the terms, reservations, restrictions and conditions of any existing or future contracts between the City and the United States, the execution of which has been or may be required as a condition precedent to the transfer of federal rights or property to the City for airport purposes, and the expenditure of federal funds for the extension, expansion or development of the Airport System.

(i) General Civil Rights: Contractor agrees to comply with pertinent statutes, Executive Orders and such rules as are promulgated to ensure that no person shall, on the grounds of race, creed, color, national origin, sex, age, or disability be excluded from participating in any activity conducted with or benefiting from Federal Assistance. This provision binds Contractor and subcontractors from the bid solicitation period through the completion of the Contract. This provision is in addition to that required of Title VI of the Civil Rights Act of 1964.

(ii) Federal Fair Labor Standards Act: This Contract incorporates by reference the provisions of 29 C.F.R. Part 201, the Federal Fair Labor Standards Act (“FLSA”), with

the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers. Contractor agrees to incorporate by reference the provisions of FLSA in all contracts and subcontracts resulting from this Contract. Contractor has full responsibility to monitor compliance to the referenced regulation. Contractor must address any claims or disputes arising from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

(iii) Occupational Safety and Health Act: This Contract incorporates by reference the requirements of 29 C.F.R. Part 1910 with the same force and effect as if given in full text. Contractor must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. Contractor retains full responsibility to monitor its compliance and any subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (29 C.F.R. Part 1910). Contractor must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

(iv) Contractor covenants it will include the provisions of this section in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Federal Acts, Regulations and directives issued pursuant thereto. Contractor covenants it will take action with respect to any subcontract or procurement as the City or the FAA may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if Contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, Contractor may request the City to enter into any litigation to protect the interests of the City. In addition, Contractor may request the United States to enter into the litigation to protect the interests of the United States.

### **30. CITY EXECUTION OF CONTRACT:**

This Contract is expressly subject to, and shall become effective upon, the execution of all signatories of the City and, if required, the approval of Denver City Council. This Contract may be executed in two or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same.

### **31. ELECTRONIC SIGNATURES AND ELECTRONIC RECORDS:**

The Contract, and any other documents requiring a signature hereunder, may be signed electronically by the City and/or Contractor in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Contract solely because it is in electronic form or because an electronic record was used in its formation. The Parties agree not to object to the admissibility of the Contract in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

**[SIGNATURE PAGES FOLLOW]**

**Contract Control Number:** PLANE-202366450-00  
**Contractor Name:** ANY VENDOR

IN WITNESS WHEREOF, the parties have set their hands and affixed their seals at Denver, Colorado as of:

**SEAL**

**CITY AND COUNTY OF DENVER:**

**ATTEST:**

By:

\_\_\_\_\_

\_\_\_\_\_

**APPROVED AS TO FORM:**

**REGISTERED AND COUNTERSIGNED:**

Attorney for the City and County of Denver

By:

By:

\_\_\_\_\_

\_\_\_\_\_

By:

\_\_\_\_\_

**Contract Control Number:**  
**Contractor Name:**

PLANE-202366450-00  
ANY VENDOR

By: \_\_\_\_\_

Name: \_\_\_\_\_  
(please print)

Title: \_\_\_\_\_  
(please print)

ATTEST: [if required]

By: \_\_\_\_\_

Name: \_\_\_\_\_  
(please print)

Title: \_\_\_\_\_  
(please print)

## **EXHIBIT A**

### **FEDERAL CONSTRUCTION CONTRACT PROVISIONS**

#### **A1.3 ACCESS TO RECORDS AND REPORTS**

The Contractor must maintain an acceptable cost accounting system. The Contractor agrees to provide the Owner, the Federal Aviation Administration and the Comptroller General of the United States or any of their duly authorized representatives access to any books, documents, papers and records of the Contractor which are directly pertinent to the specific contract for the purpose of making audit, examination, excerpts and transcriptions. The Contractor agrees to maintain all books, records and reports required under this contract for a period of not less than three years after final payment is made and all pending matters are closed.

#### **A3.3 BREACH OF CONTRACT TERMS**

Any violation or breach of terms of this contract on the part of the Contractor or its subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this agreement. The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder are in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law.

#### **A4.3.1 BUY AMERICAN PREFERENCE**

The Contractor agrees to comply with 49 USC § 50101, which provides that Federal funds may not be obligated unless all steel and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list.

A bidder or offeror must complete and submit the Buy America certification included with the Invitation to Bid or other solicitation with their bid or offer.

#### **A6.4.1 TITLE VI CLAUSES FOR COMPLIANCE WITH NONDISCRIMINATION REQUIREMENTS**

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor"), agrees as follows:

1. **Compliance with Regulations:** The Contractor (hereinafter includes consultants) will comply with the Title VI List of Pertinent Nondiscrimination Acts and Authorities, as they may be amended from time to time, which are herein incorporated by reference and made a part of this contract.

2. **Nondiscrimination:** The Contractor, with regard to the work performed by it during the contract, will not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor will not participate directly or indirectly in the discrimination prohibited by the Nondiscrimination Acts and Authorities, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR part 21.
3. **Solicitations for Subcontracts, including Procurements of Materials and Equipment:** In all solicitations, either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier will be notified by the Contractor of the contractor's obligations under this contract and the Nondiscrimination Acts and Authorities on the grounds of race, color, or national origin.
4. **Information and Reports:** The Contractor will provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the sponsor or the Federal Aviation Administration to be pertinent to ascertain compliance with such Nondiscrimination Acts and Authorities and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information, the Contractor will so certify to the sponsor or the Federal Aviation Administration, as appropriate, and will set forth what efforts it has made to obtain the information.
5. **Sanctions for Noncompliance:** In the event of a Contractor's noncompliance with the non-discrimination provisions of this contract, the sponsor will impose such contract sanctions as it or the Federal Aviation Administration may determine to be appropriate, including, but not limited to:
  - a. Withholding payments to the Contractor under the contract until the Contractor complies; and/or
  - b. Cancelling, terminating, or suspending a contract, in whole or in part.
6. **Incorporation of Provisions:** The Contractor will include the provisions of paragraphs one through six in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations, and directives issued pursuant thereto. The Contractor will take action with respect to any subcontract or procurement as the sponsor or the Federal Aviation Administration may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if the Contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, the Contractor may request the sponsor to enter into any litigation to protect the interests of the sponsor. In addition, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

#### **A6.4.5 TITLE VI LIST OF PERTINENT NONDISCRIMINATION ACTS AND AUTHORITIES**

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the “Contractor”) agrees to comply with the following non-discrimination statutes and authorities; including but not limited to:

- Title VI of the Civil Rights Act of 1964 (42 USC § 2000d *et seq.*, 78 stat. 252) (prohibits discrimination on the basis of race, color, national origin);
- 49 CFR part 21 (Non-discrimination in Federally-assisted programs of the Department of Transportation—Effectuation of Title VI of the Civil Rights Act of 1964);
- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 USC § 4601) (prohibits unfair treatment of persons displaced or whose property has been acquired because of Federal or Federal-aid programs and projects);
- Section 504 of the Rehabilitation Act of 1973 (29 USC § 794 *et seq.*), as amended (prohibits discrimination on the basis of disability); and 49 CFR part 27;
- The Age Discrimination Act of 1975, as amended (42 USC § 6101 *et seq.*) (prohibits discrimination on the basis of age);
- Airport and Airway Improvement Act of 1982 (49 USC § 471, Section 47123), as amended (prohibits discrimination based on race, creed, color, national origin, or sex);
- The Civil Rights Restoration Act of 1987 (PL 100-209) (broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, the Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms “programs or activities” to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);
- Titles II and III of the Americans with Disabilities Act of 1990, which prohibit discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities (42 USC §§ 12131 – 12189) as implemented by U.S. Department of Transportation regulations at 49 CFR parts 37 and 38;
- The Federal Aviation Administration’s Nondiscrimination statute (49 USC § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which ensures nondiscrimination against minority populations by discouraging programs, policies, and activities with disproportionately high and adverse human health or environmental effects on minority and low-income populations;
- Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, and resulting agency guidance, national origin discrimination

includes discrimination because of limited English proficiency (LEP). To ensure compliance with Title VI, you must take reasonable steps to ensure that LEP persons have meaningful access to your programs (70 Fed. Reg. at 74087 to 74100);

- Title IX of the Education Amendments of 1972, as amended, which prohibits you from discriminating because of sex in education programs or activities (20 USC 1681 et seq).

### **A7.3 CLEAN AIR AND WATER POLLUTION CONTROL**

Contractor agrees to comply with all applicable standards, orders, and regulations issued pursuant to the Clean Air Act (42 USC § 740-7671q) and the Federal Water Pollution Control Act as amended (33 USC § 1251-1387). The Contractor agrees to report any violation to the Owner immediately upon discovery. The Owner assumes responsibility for notifying the Environmental Protection Agency (EPA) and the Federal Aviation Administration.

Contractor must include this requirement in all subcontracts that exceeds \$150,000.

### **A8.3 CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS**

#### **1. Overtime Requirements.**

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic, including watchmen and guards, in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

#### **2. Violation; Liability for Unpaid Wages; Liquidated Damages.**

In the event of any violation of the clause set forth in paragraph (1) of this clause, the Contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1) of this clause, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1) of this clause.

#### **3. Withholding for Unpaid Wages and Liquidated Damages.**

The Federal Aviation Administration (FAA) or the Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or

subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2) of this clause.

4. Subcontractors.

The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs (1) through (4) and also a clause requiring the subcontractor to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1) through (4) of this clause.

### **A9.3 COPELAND “ANTI-KICKBACK” ACT**

Contractor must comply with the requirements of the Copeland “Anti-Kickback” Act (18 USC 874 and 40 USC 3145), as supplemented by Department of Labor regulation 29 CFR part 3. Contractor and subcontractors are prohibited from inducing, by any means, any person employed on the project to give up any part of the compensation to which the employee is entitled. The Contractor and each Subcontractor must submit to the Owner, a weekly statement on the wages paid to each employee performing on covered work during the prior week. Owner must report any violations of the Act to the Federal Aviation Administration.

### **A10.3 DAVIS-BACON REQUIREMENTS**

1. Minimum Wages.

- (i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Secretary of Labor under the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalent thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and

mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided* that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can easily be seen by the workers.

- (ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:
- (1) The work to be performed by the classification requested is not performed by a classification in the wage determination;
  - (2) The classification is utilized in the area by the construction industry; and
  - (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
- (B) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
- (C) In the event the Contractor, the laborers, or mechanics to be employed in the classification, or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt

and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

- (D) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(ii) (B) or (C) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.
- (iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
- (iv) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program: *Provided* that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

## 2. Withholding.

The Federal Aviation Administration or the sponsor shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of work, all or part of the wages required by the contract, the Federal Aviation Administration may, after written notice to the Contractor, Sponsor, Applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

## 3. Payrolls and Basic Records.

- (i) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 1(b)(2)(B) of the Davis-Bacon Act); daily and

weekly number of hours worked; deductions made; and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records that show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and that show the costs anticipated or the actual costs incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

- (ii)(A) The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit the payrolls to the applicant, Sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (*e.g.* the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at [www.dol.gov/whd/forms/wh347instr.htm](http://www.dol.gov/whd/forms/wh347instr.htm) or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker and shall provide them upon request to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit them to the applicant, sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration, the Contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, Sponsor, or Owner).
- (B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

- (1) The payroll for the payroll period contains the information required to be provided under 29 CFR § 5.5(a)(3)(ii), the appropriate information is being maintained under 29 CFR § 5.5 (a)(3)(i), and that such information is correct and complete;
  - (2) Each laborer and mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations 29 CFR Part 3;
  - (3) Each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
- (C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the “Statement of Compliance” required by paragraph (3)(ii)(B) of this section.
- (D) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.
- (ii) The Contractor or subcontractor shall make the records required under paragraph (3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the sponsor, the Federal Aviation Administration, or the Department of Labor and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, Sponsor, applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

#### 4. Apprentices and Trainees.

- (i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of

Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- (ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination that provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate that is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable

wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- (iii) Equal Employment Opportunity. The utilization of apprentices, trainees, and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

5. Compliance with Copeland Act Requirements.

The Contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

6. Subcontracts.

The Contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR Part 5.5(a)(1) through (10) and such other clauses as the Federal Aviation Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR Part 5.5.

7. Contract Termination: Debarment.

A breach of the contract clauses in paragraph 1 through 10 of this section may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act Requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes Concerning Labor Standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any

of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

- (i) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 USC 1001.

**A11.3.2 CERTIFICATION OF LOWER TIER CONTRACTORS REGARDING DEBARMENT**

Contractor, by administering each lower tier subcontract that exceeds \$25,000 as a "covered transaction", must verify each lower tier participant of a "covered transaction" under the project is not presently debarred or otherwise disqualified from participation in this federally assisted project. Contractor will accomplish this by:

1. Checking the System for Award Management at website: <http://www.sam.gov>.
2. Collecting a certification statement similar to the Certification of Offerer /Bidder Regarding Debarment, above.
3. Inserting a clause or condition in the covered transaction with the lower tier contract.

If the Federal Aviation Administration later determines that a lower tier participant failed to disclose to a higher tier participant that it was excluded or disqualified at the time it entered the covered transaction, the FAA may pursue any available remedies, including suspension and debarment of the non-compliant participant.

**A12.3.3 PRIME CONTRACTS (PROJECTS COVERED BY A DBE PROGRAM) DISADVANTAGED BUSINESS ENTERPRISES**

The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of Department of Transportation-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the Owner deems appropriate, which may include, but is not limited to:

- 1) Withholding monthly progress payments;
- 2) Assessing sanctions;
- 3) Liquidated damages; and/or
- 4) Disqualifying the Contractor from future bidding as non-responsible.

**Prompt Payment (§26.29) –**

The prime contractor agrees to pay each subcontractor under this prime contract for satisfactory performance of its contract no later than 30 days from the receipt of each payment the prime contractor receives from the City and County of Denver. The prime contractor agrees further to return retainage payments to each subcontractor within 30 days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time frame may occur only for good cause following written approval of the City and County of Denver. This clause applies to both DBE and non-DBE subcontractors.

**A13.3 TEXTING WHEN DRIVING**

In accordance with Executive Order 13513, "Federal Leadership on Reducing Text Messaging While Driving", (10/1/2009) and DOT Order 3902.10, "Text Messaging While Driving", (12/30/2009), the Federal Aviation Administration encourages recipients of Federal grant funds to adopt and enforce safety policies that decrease crashes by distracted drivers, including policies to ban text messaging while driving when performing work related to a grant or subgrant.

In support of this initiative, the Owner encourages the Contractor to promote policies and initiatives for its employees and other work personnel that decrease crashes by distracted drivers, including policies that ban text messaging while driving motor vehicles while performing work activities associated with the project. The Contractor must include the substance of this clause in all sub-tier contracts exceeding \$3,500 that involve driving a motor vehicle in performance of work activities associated with the project.

**A14.3 ENERGY CONSERVATION REQUIREMENTS**

Contractor and Subcontractor agree to comply with mandatory standards and policies relating to energy efficiency as contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 USC 6201 *et seq*).

**A16.3.1 EQUAL EMPLOYMENT OPPORTUNITY CLAUSE**

During the performance of this contract, the Contractor agrees as follows:

- (1) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to, the following:

employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff, or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

- (2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
- (3) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the Contractor's commitments under this section and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- (4) The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- (5) The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
- (6) In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.
- (7) The Contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however*, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

### **A16.3.2 STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS**

1. As used in these specifications:
  - a. “Covered area” means the geographical area described in the solicitation from which this contract resulted;
  - b. “Director” means Director, Office of Federal Contract Compliance Programs (OFCCP), U.S. Department of Labor, or any person to whom the Director delegates authority;
  - c. “Employer identification number” means the Federal social security number used on the Employer’s Quarterly Federal Tax Return, U.S. Treasury Department Form 941;
  - d. “Minority” includes:
    - (1) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
    - (2) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin regardless of race);
    - (3) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
    - (4) American Indian or Alaskan native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).
2. Whenever the Contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.
3. If the Contractor is participating (pursuant to 41 CFR part 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors shall be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved plan is individually required to comply with its obligations under the EEO clause and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does

not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7a through 7p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in a geographical area where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.
5. Neither the provisions of any collective bargaining agreement nor the failure by a union with whom the Contractor has a collective bargaining agreement to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.
6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees shall be employed by the Contractor during the training period and the Contractor shall have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees shall be trained pursuant to training programs approved by the U.S. Department of Labor.
7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully and shall implement affirmative action steps at least as extensive as the following:
  - a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other onsite supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
  - b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

- c. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore along with whatever additional actions the Contractor may have taken.
- d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or female sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.
- e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.
- f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
- g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination, or other employment decisions, including specific review of these items, with onsite supervisory personnel such as superintendents, general foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
- h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other contractors and subcontractors with whom the Contractor does or anticipates doing business.

- i. Direct its recruitment efforts, both oral and written, to minority, female, and community organizations, to schools with minority and female students; and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations, such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
  - j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a contractor's workforce.
  - k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.
  - l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel, for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
  - m. Ensure that seniority practices, job classifications, work assignments, and other personnel practices do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.
  - n. Ensure that all facilities and company activities are non-segregated except that separate or single user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
  - o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
  - p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.
8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative action obligations (7a through 7p). The efforts of a contractor association, joint contractor union, contractor community, or other similar groups of which the Contractor is a member and participant may be asserted as fulfilling any one or more of its obligations under 7a through 7p of these specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and

female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, if the particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally), the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized.
10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.
11. The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246. 12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.
13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR part 60-4.8.
14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government, and to keep records. Records shall at least include for each employee, the name, address, telephone number, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g. those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

### **A17 FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)**

This Contract incorporates by reference the provisions of 29 CFR part 201, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers.

The Contractor has full responsibility to monitor compliance to the referenced statute or regulation. The Contractor must address any claims or disputes that arise from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

### **A18.3 CERTIFICATION REGARDING LOBBYING**

The Bidder or Offeror certifies by signing and submitting its bid or proposal, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

### **A19.3 PROHIBITION OF SEGREGATED FACILITIES**

- (a) The Contractor agrees that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Contractor agrees that a breach of this clause is a violation of the Equal Employment Opportunity clause in this contract.
- (b) “Segregated facilities,” as used in this clause, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, or national origin because of written or oral policies or employee custom. The term does not include separate or single-user rest rooms or necessary dressing or sleeping areas provided to assure privacy between the sexes.
- (c) The Contractor shall include this clause in every subcontract and purchase order that is subject to the Equal Employment Opportunity clause of this contract.

### **A20.3 OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970**

This Contract incorporates by reference the requirements of 29 CFR Part 1910 with the same force and effect as if given in full text. The employer must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. The employer retains full responsibility to monitor its compliance and their subcontractor’s compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (20 CFR Part 1910). The employer must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

### **A21.3 PROCUREMENT OF RECOVERED MATERIALS**

Contractor and subcontractor agree to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, and the regulatory provisions of 40 CFR Part 247. In the performance of this contract and to the extent practicable, the Contractor and subcontractors are to use products containing the highest percentage of recovered materials for items designated by the Environmental Protection Agency (EPA) under 40 CFR Part 247 whenever:

- 1) The contract requires procurement of \$10,000 or more of a designated item during the fiscal year; or
- 2) The contractor has procured \$10,000 or more of a designated item using Federal funding during the previous fiscal year.

The list of EPA-designated items is available at [www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products](http://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products).

Section 6002(c) establishes exceptions to the preference for recovery of EPA-designated products if the contractor can demonstrate the item is:

- a) Not reasonably available within a timeframe providing for compliance with the contract performance schedule;
- b) Fails to meet reasonable contract performance requirements; or
- c) Is only available at an unreasonable price.

### **A22.3 RIGHTS TO INVENTIONS**

Contracts or agreements that include the performance of experimental, developmental, or research work must provide for the rights of the Federal Government and the Owner in any resulting invention as established by 37 CFR part 401, Rights to Inventions Made by Non-profit Organizations and Small Business Firms under Government Grants, Contracts, and Cooperative Agreements. This contract incorporates by reference the patent and inventions rights as specified within 37 CFR §401.14. Contractor must include this requirement in all sub-tier contracts involving experimental, developmental, or research work.

#### **A23.3.2 SEISMIC SAFETY**

The Contractor agrees to ensure that all work performed under this contract, including work performed by subcontractors, conforms to a building code standard that provides a level of seismic safety substantially equivalent to standards established by the National Earthquake Hazards Reduction Program (NEHRP). Local building codes that model their code after the current version of the International Building Code (IBC) meet the NEHRP equivalency level for seismic safety.

### **A24.3 CERTIFICATION OF OFFERER/BIDDER REGARDING TAX DELINQUENCY AND FELONY CONVICTIONS**

Contractor's Certification regarding Tax Delinquency and Felony Convictions, submitted with its bid or proposal, is incorporated by reference as if fully restated herein. No Federal funds shall be paid to any contractor who has been convicted of a Federal felony within the last 24 months; or who has any outstanding tax liability for which all judicial and administrative remedies have lapsed or been exhausted.

#### **A25.3.2 TERMINATION FOR DEFAULT (CONSTRUCTION)**

Section 80-09 of FAA Advisory Circular 150/5370-10 establishes conditions, rights, and remedies associated with Owner termination of this contract due to default of the Contractor.

### **A27.3 VETERAN'S PREFERENCE**

In the employment of labor (excluding executive, administrative, and supervisory positions), the Contractor and all sub-tier contractors must give preference to covered veterans as defined within Title 49 United States Code Section 47112. Covered veterans include Vietnam-era veterans, Persian Gulf veterans, Afghanistan-Iraq war veterans, disabled veterans, and small business concerns (as defined by 15 USC 632) owned and controlled by disabled veterans. This preference only applies when there are covered veterans readily available and qualified to perform the work to which the employment relates.

**EXHIBIT B**

**CITY AND COUNTY OF DENVER  
RULES AND REGULATIONS AND BID  
CONDITIONS OF THE  
MANAGER OF PUBLIC WORKS**

**PERTAINING TO EQUAL EMPLOYMENT OPPORTUNITY  
IN THE CITY AND COUNTY OF DENVER**

APPROVED FOR LEGALITY:

APPROVED AND ADOPTED:

/s/ \_\_\_\_\_  
Attorney for the City and  
County of Denver

/s/ \_\_\_\_\_  
Manager of Public Works

Adopted and Published Pursuant to Article 111, Division 2 of Chapter 28  
the Revised Municipal Code  
of the City and County of Denver

These Rules and Regulations cancel and supersede any and all previous issued Rules and  
Regulations on the subject

Vendor Name

Contract No. xxxxxxxxxxx-xx

**RULES AND REGULATIONS**  
**REGARDING**  
**EQUAL EMPLOYMENT OPPORTUNITY**

Promulgated and adopted by the Manager of Public Works pursuant to and by authority of Article III, Division 2, Chapter 28 of the Revised Municipal Code of the City and County of Denver, and for the purpose of insuring that contractors, subcontractors and suppliers soliciting and receiving compensation for contract work from or through the City and County of Denver provide equal opportunity in employment without regard to race, color, creed, sex, national origin, age, religion, marital status, political opinion or affiliation or mental or physical handicap and meet certain requirements for the hiring, training, promotion and treatment during employment of members of ethnic groups subjected to differential treatment, including persons of African descent (Black), Spanish-surnamed (Hispanic), Asian-American and American Indian groups.

**RULE I**  
**DEFINITIONS**

- A. "City" means the City and County of Denver.
- B. "Manager" shall mean the Manager of Public Works for the City and County of Denver.
- C. "Contract" means a contract entered into with the City and County of Denver, financed in whole or in part by local resources or funds of the City and County of Denver, for the construction of any public building or prosecution or completion of any public work.
- D. "Contractor" means the original party to a contract with the City and County of Denver, also referred to as the "general" or "prime" contractor.
- E. "Director" means the Director of the Mayor's Office of Contract Compliance.
- F. "Subcontractor" means any person, company, association, partnership, corporation, or other entity which assumes by subordinate agreement some or all of the obligations of the general or prime contractor.
- G. The Phrase "Bidding Specifications" as used in Article 111, Division 2 of Chapter 28 of the Revised Municipal Code shall include BID CONDITION, INVITATION TO BID AND NOTICE OF PROPOSAL.
- H. "Affirmative Action Program" means a set of specific and result-oriented procedures or steps to which a contractor commits himself to apply every good faith effort to employ members of ethnic minority groups, to include persons of African descent (Black), Spanish surnamed (Hispanic), Asian-American, American Indians, and persons with mental or physical handicap.
- I. "Mayor's Office of Contract Compliance" means the City agency established pursuant to Article III, Division 1 of Chapter 28 of the Denver Revised Municipal Code.

**RULE II**  
**NOTICE OF HEARING**

When results of conciliation efforts are unsatisfactory to the Manager and he is informed in accordance with Article III, Division 2 of Chapter 28 of the Revised Municipal Code that a contractor or subcontractor has apparently failed to meet affirmative action and equal employment opportunity requirements after a reasonable period of notice to correct deficiencies, the Manager will, prior to imposition of any sanctions, afford the general contractor a hearing in order to determine whether the contractor or his subcontractors have failed to comply with the affirmative action and equal employment opportunity requirements of Article III, Division 2 of Chapter 28 of the Revised Municipal Code or of the contract. Written notice of such hearing shall be delivered personally or sent by certified mail return receipt requested, to the contractor and to any subcontractor involved at least ten days prior to the date scheduled for the hearing.

**RULE III**  
**HEARING**

- A. Contractors will appear at hearings and may be represented by counsel, and may present testimony orally and other evidence.
- B. Hearings shall be conducted by one or more hearing examiners designated as such by the Manager.
- C. The Director of the Mayor's Office of Contract Compliance may participate in hearings as a witness.
- D. Hearings shall be held at the place specified in the notice of hearing.
- E. All oral testimony shall be given under oath or affirmation and a record of such proceedings shall be made.
- F. All hearings shall be open to the public.
- G. The hearing officer shall make recommendations to the Manager who shall make a final decision.

**REGULATIONS**

**REGULATION NO. 1. ORDINANCE:** The Rules and Regulations of the Manager shall be inserted in the bidding specifications for every contract for which bidding is required.

**REGULATION NO. 2. EXEMPTIONS:** Each contract and subcontract, regardless of dollar amount, shall be subject to affirmative action requirements unless specifically exempted in writing individually by the Manager. Exemptions apply only to "affirmative action" in equal employment opportunity, and are not to be construed as condonation in any manner of "discrimination" or "discriminatory practices" in employment because of race, color, creed sex age national origin, religion, marital status, political opinion or mental or physical handicap.

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**REGULATION NO. 3. DIRECTOR OF CONTRACT COMPLIANCE:** The Director of the Mayor's Office of Contract Compliance shall perform the duties assigned to such official by Article III, Division 2 of Chapter 28 of the Revised Municipal Code and by the Manager. (1) The Director of the Mayor's Office of Contract Compliance or designated representatives shall inform bidders and contractors of affirmative action procedures, programs, and goals in accordance with the ordinance at pre-bid and pre-construction conference; (2) make regular on-site inspections; (3) supply contractors and subcontractors with report forms to be completed by them when requested, and furnished to the Director of the Mayor's Office of Contract Compliance; and (4) review payroll records, employment records and practices of general contractors and their subcontractors and suppliers during the performance of any contract. The Director of the Mayor's Office of Contract Compliance shall promptly report apparent affirmative action deficiencies to the Manager.

**REGULATION NO. 4. GOALS AND TIMETABLES:** In general, goals and timetables should take into account anticipated vacancies and the availability of skills in the market place from which employees should be drawn. In addition, where discrimination in employment by a general contractor or any of his subcontractors is indicated, a corrective action program will take into account the need by the general contractor and his subcontractors to correct past discriminatory practices and reach goals of minority manpower utilization on a timely basis through such recruiting and advertising efforts as are necessary and appropriate.

**REGULATION NO.5. AWARD OF CONTRACTS:** It shall be the responsibility of the Director of the Mayor's Office of Contract Compliance to determine the affirmative action capability of bidders, contractors and subcontractors and to recommend to the Manager the award of contracts to those bidders, contractors and subcontractors and suppliers who demonstrate the ability and willingness to comply with the terms of their contract.

**REGULATION NO. 6. PUBLICATION AND DUPLICATION:** Copies of these Rules and Regulations as amended by the Manager from time to time, shall as soon as practicable and after Notice being published will be made a part of all City Contracts.

**REGULATION NO. 7. NOTICE TO PROCEED:** Prior to issuance of Notice to Proceed a sign-off will be required of the Director of the Mayor's Office of Contract Compliance or his designee.

**REGULATION NO. 8. CONTRACTS WITH SUBCONTRACTORS:** To the greatest extent possible the contractor shall make a good faith effort to contract with minority contractors, subcontractors and suppliers for services and supplies by taking affirmative actions which include but are not limited to the following:

1. Advertise invitations for subcontractor bids in minority community news media.
2. Contact minority contractor organizations for referral of prospective subcontractors.
3. Purchase materials and supplies from minority material suppliers.

**REGULATION NO. 9. AGENCY REFERRALS:** it shall be no excuse that the union with which the contractor or subcontractor has an agreement providing for referral, exclusive or otherwise, failed to refer minority employees.

Vendor Name

Contract No. xxxxxxxxxxx-xx

**REGULATION NO. 10. CLAUSES:** The Manager shall include the appropriate clauses in every contract and the contractor shall cause to be inserted in every subcontract the appropriate clauses:

1. **APPENDIX A:** City and County of Denver Equal Opportunity Clause-ALL CONTRACTS funded only with City & County of Denver monies.
2. **APPENDIX B:** Equal Opportunity Clause (11246)-ALL FEDERAL ASSISTED
3. **APPENDIX C:** Section 3-Assurance of Compliance-HUD ASSISTED PROJECTS.
4. **APPENDIX D:** Section 3-Clause-HUD ASSISTED PROJECTS.

All amendments to the appendices shall be included by reference.

**REGULATION NO. 11. SHOW CAUSE NOTICES:** When the Manager has reasonable cause to believe that a contractor has violated Article III, Division 2 of Chapter 28 of the Revised Municipal Code, he may issue a notice requiring the contractor to show cause, within fifteen days why enforcement procedures, or other appropriate action to insure compliance, should not be instituted.

**REGULATION NO. 12. BID CONDITIONS-AFFIRMATIVE ACTION REQUIREMENTS-EQUAL EMPLOYMENT OPPORTUNITY:**

**1. APPENDIX E:**

The Bid Conditions- Affirmative Action Requirements-Equal Employment Opportunity as amended and published by the U.S. Department of Labor, Employment Standards Administration, Office of Federal Contract Compliance, shall be inserted verbatim for bidding specification for every non-exempt contract involving the use of Federal funds.

**2. APPENDIX F:**

The Bid Conditions- Affirmative Action Requirements-Equal Employment Opportunity as published by the Department of Public Works, City and County of Denver shall be inserted verbatim as bidding specifications for every non-exempt contract using City funds.

**APPENDIX A**

**CITY AND COUNTY OF DENVER EQUAL OPPORTUNITY CLAUSE-ALL CONTRACTS**

1. The contractor will not discriminate against any employee or applicant for employment because of race creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap.
3. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Each contractor will comply with all provisions of Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager and Director.
5. The contractor will furnish all information and reports required by Article III, Division 2, Chapter 28 of the Revised Municipal Code, and by rules, regulations and orders of the Manager and Director or pursuant thereto, and will permit access to his books, records, and accounts by the Manager, Director or their designee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations or orders this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further City contracts in accordance with procedures authorized in Article III, Division 2, Chapter 28 of the Revised Municipal Code, or by rules, regulations, or order of the Manager.
7. The contractor will include Regulation 12 Paragraph 2 and the provisions of paragraphs (1) through (6) in every subcontract or purchase order unless, exempted by rules, regulations, or orders of the Manager issued pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, so that such provisions will be binding upon each subcontractor or suppliers. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance.

Vendor Name

Contract No. xxxxxxxxxxx-xx

The applicant further agrees to be bound by the above equal opportunity clauses with respect to its own employment practices when it participates in City contracts. The contractor agrees to assist and cooperate actively with the Manager and the Director in obtaining compliance of subcontractors and suppliers with the equal opportunity clause and the rules, regulations and relevant orders of the Manager, and will furnish the Manager and the Director such information as they may require for the supervision of compliance, and will otherwise assist the Manager and Director in the discharge of the City's primary responsibility for securing compliance. The contractor further agrees to refrain from entering into any contract or contract modification subject to Article III, Division 2, Chapter 28 of the Revised Municipal Code with a contractor debarred from, or who has not demonstrated eligibility for, City contracts.

The contractor will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the Manager and Director. In addition, the contractor agrees that failure or refusal to comply with these undertakings the Manager may take any or all of the following actions:

- A. Cancellation, termination, or suspension in whole or in part of this contract.
- B. Refrain from extending any further assistance to the applicant under the program with respect to which the failure occurred until satisfactory assurance of future compliance has been received from such applicant.
- C. Refer the case to the City Attorney for appropriate legal proceedings.

**SUBCONTRACTS:** Each prime contractor or subcontractor shall include the equal opportunity clause in each of its subcontracts.

**APPENDIX F  
BID CONDITIONS  
AFFIRMATIVE ACTION REQUIREMENTS  
EQUAL EMPLOYMENT OPPORTUNITY**

For all Non-Exempt Construction Contracts to be Awarded by  
the City and County of Denver, Department of Public Works

**NOTICE**

EACH BIDDER, CONTRACTOR OR SUBCONTRACTOR (HEREINAFTER THE CONTRACTOR) MUST FULLY COMPLY WITH THE REQUIREMENTS OF THESE BID CONDITIONS AS TO EACH CONSTRUCTION TRADE IT INTENDS TO USE ON THIS CONSTRUCTION CONTRACT, AND ALL OTHER CONSTRUCTION WORK (BOTH CITY AND NON-CITY) IN THE DENVER AREA DURING THE PERFORMANCE OF THIS CONTRACT OR SUBCONTRACT. THE CONTRACTOR COMMITS ITSELF TO THE GOALS FOR MINORITY MANPOWER UTILIZATION, AS APPLICABLE, AND ALL OTHER REQUIREMENTS, TERMS AND CONDITION OF THESE BID CONDITIONS BY SUBMITTING A PROPERLY SIGNED BID.

THE CONTRACTOR SHALL APPOINT A COMPANY EXECUTIVE TO ASSUME THE RESPONSIBILITY FOR THE IMPLEMENTATION OF THE REQUIREMENTS, TERMS AND CONDITIONS OF THESE BID CONDITIONS.

EULOIS CLECKLEY  
Manager of Public Works  
City and County of Denver

Vendor Name

Contract No. xxxxxxxxxxx-xx

**A. REQUIREMENTS --AN AFFIRM ATIVE ACTION PLAN:**

Contractors shall be subject to the provisions and requirements of these bid conditions including the goals and timetables for minority' and female utilization, and specific affirmative action steps set forth by the Office of Contract Compliance. The contractor's commitment to the goals for minority, and female utilization as required constitutes a commitment that it will make every good faith effort to meet such goals.

**1. GOALS AND TIMETABLES:**

The goals and timetables for minority<sup>1</sup> and female participation, expressed in percentage terms for the contractor's aggregate workforce in each trade are as follows:

**GOALS FOR MINORITY PARTICIPATION FOR EACH TRADE**

From January 1, 1982  
to 21.7% - 23.5%  
Until Further Notice

**GOALS FOR FEMALE PARTICIPATION FOR EACH TRADE**

From January 1, 1982  
to 6.9%  
Until Further Notice

The goals for minority and female utilization above are expressed in terms of hours of training and employment as a proportion of the total number of hours to be worked by the contractor's aggregate workforce, which includes all supervisory personnel, in each trade, on all projects for the City and County of Denver during the performance of its contract (i.e., The period beginning with the first day of work on the City and County of Denver funded construction contract and ending with the last day of work).

The hours of minority and female employment and training must be substantially uniform throughout the length of the contract in each trade and minorities and females must be employed evenly on each of a contractor's projects. Therefore, the transfer of minority or female employees from contractor to contractor or from project to project for the purpose of meeting the contractor's goals shall be a violation of these Bid Conditions.

If the contractor counts the nonworking hours of apprentices they must be employed by the contractor during the training period; the contractor must have made a commitment to employ apprentices at the completion of their training subject to the availability of employment opportunities; and the apprentices must be trained pursuant to training programs approved by the Bureau of Apprenticeship and Training.

<sup>1</sup> "Minority" is defined as including, Blacks, Spanish Surname Americans, Asian-Americans, and American Indians, and includes both men and Minority women.

## 2. **SPECIFIC AFFIRMATIVE ACTION STEPS:**

No contractor shall be found to be in noncompliance solely on account of its failure to meet its goals, but will be given an opportunity to demonstrate that the contractor has instituted all the specific affirmative action steps specified and has made every good faith effort to make these steps work toward the attainment of its goals within the timetables, all to the purpose of expanding minority and female utilization in its aggregate workforce. A contractor, who fails to comply with its obligation under the Equal Opportunity Clause of its contract and fails to achieve its commitments to the goals for minority and female utilization has the burden of proving that it has engaged in an Affirmative Action Program directed at increasing minority and female utilization and that such efforts were at least as extensive and as specific as the following:

- a. The contractor should have notified minority and female organizations when employment opportunities were available and should have maintained records of the organization's response.
- b. The contractor should have maintained a file of the names and addresses of each minority and female referred to it by any individual or organization and what action was taken with respect to each such referred individual, and if the individual was not employed by the contractor, the reasons. If such individual was sent to the union hiring hall for referral and not referred back by the union or if referred, not employed by the contractor, the file should have documented this and their reasons.
- c. The contractor should have promptly notified the Department of Public Works, and Mayor's Office of Contract Compliance when the union or unions with which the contractor has collective bargaining agreements did not refer to the contractor a minority or female sent by the contractor, or when the contractor has other information that the union referral process has impeded efforts to meet its goals.
- d. The contractor should have disseminated its EEO policy within its organization by including it in any employee handbook or policy manual; by publicizing it in company newspapers and annual reports and by advertising such policy at reasonable intervals in union publications. The EEO policy should be further disseminated by conducting staff meetings to explain and discuss the policy; by posting of the policy; and by review of the policy with minority and female employees.
- e. The contractor should have disseminated its EEO policy externally by informing and discussing it with all recruitment sources; by advertising in news media, specifically including minority and female news media; and by notifying and discussing it with all subcontractors.
- f. The contractor should have made both specific and reasonably recurrent written and oral recruitment efforts. Such efforts should have been directed at minority and female organizations, schools with substantial minority and female enrollment, and minority and female recruitment and training organizations within the contractor's recruitment area.

- g. The contractor should have evidence available for inspection that all tests and other selection techniques used to select from among candidates for hire, transfer, promotion, training, or retention are being used in a manner that does not violate the OFCCP Testing Guidelines in 41 CFR Part 60-3.
- h. The contractor should have made sure that seniority practices and job classifications do not have a discriminatory effect.
- i. The contractor should have made certain that all facilities are not segregated by race.
- j. The contractor should have continually monitored all personnel activities to ensure that its EEO policy was being carried out including the evaluation of minority and female employees for promotional opportunities on a quarterly basis and the encouragement of such employees to seek those opportunities.
- k. The contractor should have solicited bids for subcontracts from available minority and female subcontractors engaged in the trades covered by these Bid conditions, including circulation of minority and female contractor associations.

**NOTE:** The Director and the Mayor's Office of Contract Compliance will provide technical assistance on questions pertaining to minority and female recruitment sources, minority and female community organizations, and minority and female news media upon receipt of a request for assistance from a contractor.

**3. NON-DISCRIMINATION:**

In no event may a contractor utilize the goals and affirmative action steps required in such a manner as to cause or result in discrimination against any person on account of race, color, religion, sex, marital status, national origin, age, mental or physical handicap, political opinion or affiliation.

**4. COMPLIANCE AND ENFORCEMENT:**

In all cases, the compliance of a contractor will be determined in accordance with its obligations under the terms of these Bid Conditions. All contractors performing or to perform work on projects subject to these Bid Conditions hereby agree to inform their subcontractors in writing of their respective obligations under the terms and requirements of these Bid Conditions, including the provisions relating to goals of minority and female employment and training.

**A. Contractors Subject to these Bid Conditions:**

In regard to these Bid Conditions, if the contractor meets the goals set forth therein or can demonstrate that it has made every good faith effort to meet these goals, the contractor shall be presumed to be in compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, the implementing regulations and its obligations under these Bid Conditions. In the event, no formal sanctions or proceedings leading toward sanctions shall be instituted unless the contracting or administering agency otherwise determines that the contractor is violating the Equal Opportunity Clause.

- 1. Where the Office of Contract Compliance finds that a contractor failed to comply with the requirements of Article 111, Division 2, Chapter 28 of the Revised Municipal

Code or the implementing regulations and the obligations under these Bid Conditions, and so informs the Manager, the Manager shall take such action and impose such sanctions, which include suspension, termination, cancellation, and debarment, as may be appropriate under the Ordinance and its regulations. When the Manager proceeds with such formal action it has the burden of proving that the contractor has not met the goals contained in these Bid Conditions. The contractor's failure to meet its goals shall shift to it the requirement to come forward with evidence to show that it has met the good faith requirements of these Bid Conditions.

2. The pendency of such proceedings shall be taken into consideration by the Department of Public Works in determining whether such contractor can comply with the requirements of Article 111, Division 2, Chapter 28 of the Revised Municipal Code, and is therefore a "responsible prospective contractor".
3. The Mayor's Office of Contract Compliance shall review the contractor's employment practices during the performance of the contract. If the Mayor's Office of Contract Compliance determines that the contractor's Affirmative Action Plan is no longer an acceptable program, the Director shall notify the Manager.

B. **Obligations Applicable to Contractors:**

It shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority or female employees. Discrimination in referral for employment, even if pursuant to provisions of a collective bargaining agreement, is prohibited by the National Labor Relations Act, as amended, Title VI of the Civil Rights Act of 1964, as amended, and Article III, Division 2, Chapter 28 of the Revised Municipal Code. It is the policy of the Department of Public Works that contractors have a responsibility to provide equal employment opportunity, if they wish to participate in City and County of Denver contracts. To the extent they have delegated the responsibility for some of their employment practices to a labor organization and, as a result, are prevented from meeting their obligations pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, such Contractors cannot be considered to be in compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, or its implementing rules and regulations.

C. **General Requirements**

Contractors are responsible for informing their subcontractors in writing regardless of tier, as to their respective obligations. Whenever a contractor subcontracts a portion of work in any trade covered by these Bid Conditions, it shall include these Bid Conditions in such subcontracts and each subcontractor shall be bound by these Bid Conditions to the full extent as if it were the prime contractor. The contractor shall not, however, be held accountable for the failure of its subcontractors to fulfill their obligations under these Bid Conditions. However, the prime contractor shall give notice to the Director of any refusal or failure of any subcontractor to fulfill the obligations under these Bid Conditions. A subcontractor's failure to comply will be treated in the same manner as such failure by a prime contractor.

1. Contractors hereby agree to refrain from entering into any contract or contract modification subject to Article 111, Division 2, Chapter 28 of the Revised Municipal Code with a contractor debarred from, or who is determined not to be a "responsive" bidder for the City and County of Denver contracts pursuant to the Ordinance.
2. The contractor shall carry out such sanctions and penalties for violation of these Bid Conditions and the Equal Opportunity Clause including suspension, termination and cancellation of existing subcontracts and debarment from future contracts as may be ordered by the Manager pursuant to Article 111, Division 2, Chapter 28 of the Revised Municipal Code and its implementing regulations.
3. Nothing herein is intended to relieve any contractor during the term of its contract from compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the Equal Opportunity Clause of its contract with respect to matters not covered in these Bid Conditions.
4. Contractors must keep such records and file such reports relating to the provisions of these Bid Conditions as shall be required by the Office of Contract Compliance.
5. Requests for exemptions from these Bid Conditions must be made in writing, with justification, to the Manager of Public Works, City and County Building, Room 379, Denver, Colorado 80202, and shall be forwarded through and with the endorsement of the Director.

**EXHIBIT C**

**CITY AND COUNTY OF DENVER  
INSURANCE REQUIREMENTS FOR DEPARTMENT OF AVIATION  
OWNER CONTROLLED INSURANCE PROGRAM (OCIP/ROCIP) PROJECT**

**NOTICE OF CHANGE TO ROCIP:** DEN reserves the right to terminate or modify the DEN ROCIP or any portion thereof. Further, dependent on factors including, but not limited to, the official timing and duration of the ROCIP project for which services are provided under this Agreement, DEN may need to transition from one ROCIP program to another and introduce corresponding requirements for contractors. DEN will provide Contractor notice in accordance with the terms and conditions of this Agreement.

**1. General Information**

City and County of Denver and Denver International Airport (hereinafter referred to collectively as “DEN”) has arranged for certain construction activities at DEN to be insured under an Owner Controlled Insurance Program (OCIP) or a Rolling Owner Controlled Insurance Program (ROCIP) (hereinafter collectively referred to as “ROCIP”). A ROCIP is a single insurance program that insures DEN, the Contractor and subcontractors of any tier, and other designated parties (Enrolled Parties), for work performed at the Project Site. Certain trade contractors and subcontractors are ineligible for this program; see ROCIP Insurance Manual Section 4. Insurance requirements are determined based on the scope of work.

## 1.2 ROCIP Manuals

Below are links to access the current reference manuals related to DEN ROCIP. These manuals are part of the Contract Documents.

[ROCIP Insurance Manual](#)

[ROCIP Safety Manual](#)

[ROCIP Claims Guide](#)

**2. Insurance Requirements for Non-ROCIP Contractors and Subcontractors (Ineligible Parties)**

Contractor and subcontractors of any tier shall require all Ineligible Parties, as defined in ROCIP Insurance Manual Section 4 or confirmed as excluded by DEN, to provide and maintain insurance of the type and in limits as set forth in the Contractor Subcontract Agreement and such insurance shall include the minimum defined coverages and be evidenced to DEN as required in this Section 2.

## 2.1 Certificate Holder

Certificate(s) shall be issued to:	CITY AND COUNTY OF DENVER Denver International Airport 8500 Peña Boulevard, Suite 8810 Denver CO 80249 Attn: Risk Management
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## 2.2 Acceptable Certificate of Insurance Form and Submission Instructions

**Please read these requirements carefully to ensure proper documentation and receipt of your certificate(s) of insurance.**

- ACORD FORM (or equivalent) certificate is required.
- SUBMIT via emailed in pdf format to: [contractadmininvoices@flydenver.com](mailto:contractadmininvoices@flydenver.com)
- ELECTRONIC CERTIFICATES are required, hard copy documents will not be accepted.

- THIRD PARTY SOFTWARE may be implemented during the term of this Agreement to manage insurance compliance and documents with required use by Vendor of such system.
- REFERENCE on the certificate must include the DEN assigned Contract Number.

## 2.3 Coverage and Limits

### 2.3.1 Commercial General Liability

Contractor shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, independent contractors, and products and completed operations in minimum limits of \$1,000,000 each occurrence, \$2,000,000 products and completed operations aggregate; if policy contains a general aggregate, a minimum limit of \$2,000,000 annual aggregate must be maintained.

2.3.1.1 Coverage shall include Contractual Liability covering liability assumed under this Agreement (including defense costs assumed under contract) within the scope of coverages provided.

2.3.1.2 Coverage shall include Mobile Equipment Liability, if used to perform services under this Agreement.

### 2.3.2 Business Automobile Liability

Contractor shall maintain a minimum limit of \$1,000,000 combined single limit each occurrence for bodily injury and property damage for all owned, leased, hired and/or non-owned vehicles used in performing services under this Agreement.

2.3.2.1 If operating vehicles unescorted airside at DEN, a \$10,000,000 combined single limit each occurrence for bodily injury and property damage is required.

2.3.2.2 If Contractor does not have blanket coverage on all owned and operated vehicles and will require unescorted airside driving privileges, then a schedule of insured vehicles (including year, make, model and VIN number) must be submitted with the Certificate of Insurance.

2.3.2.3 If transporting waste, hazardous material, or regulated substances, Contractor shall carry a Broadened Pollution Endorsement and an MCS 90 endorsement on its policy.

2.3.2.4 If Contractor does not own any fleet vehicles and Contractor's owners, officers, directors, and/or employees use their personal vehicles to perform services under this Agreement, Contractor shall ensure that one or both of the following coverages are maintained as appropriate: (i) Personal Automobile Liability including a Business Use Endorsement by the vehicle owner and (ii) Non-Owned Auto Liability by the Contractor.

2.3.2.5 If Contractor will be completing all services to DEN under this Agreement remotely and not be driving to locations under direction of the City to perform services, this requirement is waived.

### 2.3.3 Workers' Compensation and Employer's Liability Insurance

Contractor shall maintain the coverage as required by statute for each work location and shall maintain Employer's Liability insurance with limits no less than \$1,000,000 per occurrence for each bodily injury claim, \$1,000,000 per occurrence for each bodily injury caused by disease claim, and \$1,000,000 aggregate for all bodily injuries caused by disease claims.

2.3.3.1 Colorado Workers' Compensation Act allows for certain, limited exemptions from Worker's Compensation insurance coverage requirements. It is the sole responsibility of the Contractor to determine their eligibility for providing this coverage, executing all required documentation with the State of Colorado, and obtaining all necessary approvals. Verification document(s) evidencing exemption status must be submitted with the Certificate of Insurance.

#### 2.3.4 Professional Liability (Errors and Omissions) Insurance

Contractor shall maintain a minimum limit of \$1,000,000 each claim and policy aggregate, providing coverage for applicable services outlined in this Agreement. If there are no applicable professional services, this coverage will not be required.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

#### 2.3.5 Contractor's Pollution Legal Liability

If required by DEN Risk Management for any specific Excluded Party based on their scope of work, Contractor shall maintain coverage for its work site operations that are conducted on DEN's premises including project management and site supervision duties with a limit no less than \$1,000,000 each occurrence and aggregate resulting from claims arising out of a pollution condition or site environmental condition resulting out of work site operations on DEN's premises.

2.3.5.1 Coverage shall include claims/losses for bodily injury, property damage including loss of use of damaged property, defense costs including costs and expenses incurred in the investigation, defense or settlement of claims, and cleanup cost for pollution conditions resulting from illicit abandonment, the discharge, dispersal, release, escape, migration or seepage of any solid, liquid, gaseous or thermal irritant, contaminant, or pollutant, including soil, silt, sedimentation, smoke, soot, vapors, fumes, acids, alkalis, chemicals, electromagnetic fields, hazardous substances, hazardous materials, waste materials, low level radioactive waste, mixed wastes, on, in, into, or upon land and structures thereupon, the atmosphere, surface water or groundwater on the DEN premises.

2.3.5.2 Work site means a location where covered operations are being performed, including real property rented or leased from DEN for the purpose of conducting Contractor's covered operations.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

#### 2.3.6 Cyber Liability

If required by DEN Risk Management for any specific Excluded Party based on their scope of work, Contractor shall maintain a minimum limit of \$1,000,000 per occurrence and \$1,000,000 annual policy aggregate covering claims involving privacy violations, information theft, damage to or destruction of electronic information, intentional and/or unintentional release of private information, alteration of electronic information, extortion, and network security.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

2.3.7 Technology Errors and Omissions, Network Security, and Privacy Liability (Cyber):  
If required by DEN Risk Management for any specific Excluded Party based on their scope of work, Contractor shall maintain a limit no less than \$1,000,000 each claim and aggregate; \$1,000,000 each claim and aggregate for cyber extortion; and no less than \$250,000 each claim for invoice manipulation and email spoofing.

2.3.7.1 Coverage shall include, but not be limited to, liability arising from theft, dissemination and/or use of personal, private, confidential, information subject to a non-disclosure agreement, including information stored or transmitted, privacy or cyber laws, damage to or destruction of information, intentional and/or unintentional release of private information, alteration of information, extortion and network security, introduction of a computer virus into, or otherwise causing damage to, a customer's or third person's computer, computer system, network or similar computer related property and the data, software, and programs thereon, advertising injury, personal injury (including invasion of privacy) and intellectual property offenses related to internet.

The Contractor shall be responsible for conferring with DEN Risk Management on any subcontractors providing work to the Project to obtain a formal determination if this coverage will be required.

2.3.8 Unmanned Aerial Vehicle (UAV) Liability

If Contractor desires to use drones in any aspect of its work on DEN premises, the following requirements must be met prior to commencing any drone operations:

- 2.3.8.1 Express written permission must be granted by DEN.
- 2.3.8.2 Express written permission must be granted by the Federal Aviation Administration (FAA).
- 2.3.8.3 Drone equipment must be properly registered with the FAA.
- 2.3.8.4 Drone operator(s) must be properly licensed by the FAA.
- 2.3.8.5 Contractor must maintain UAV Liability including flight coverage, personal and advertising injury liability, and hired/non-owned UAV liability for its commercial drone operations with a limit no less than \$1,000,000 combined single limit each occurrence for bodily injury and property damage.

2.3.9 Excess/Umbrella Liability

Combination of primary and excess coverage may be used to achieve minimum required coverage limits. Excess/Umbrella policy(ies) must follow form of the primary policies with which they are related to provide the minimum limits and be verified as such on any submitted Certificate of Insurance.

2.4 Reference to Project and/or Contract

The DEN Project and/or Contract Number and project description shall be noted on the Certificate of Insurance.

2.5 Additional Insured

For all coverages required under this Agreement (excluding Workers' Compensation and Professional Liability, if required), Contractor's insurer(s) shall include the City and County of Denver, its elected and appointed officials, successors, agents, employees and volunteers as Additional Insureds by policy endorsement.

## 2.6 Waiver of Subrogation

For all coverages required under this Agreement (excluding Professional Liability, if required), Contractor's insurer(s) shall waive subrogation rights against the City and County of Denver, its elected and appointed officials, successors, agents, employees and volunteers by policy endorsement.

If Contractor will be completing all services to the City under this Agreement remotely and not be traveling to locations under direction of the City to perform services, this requirement is waived specific to Workers' Compensation coverage.

## 2.7 Notice of Material Change, Cancellation or Nonrenewal

Each certificate and related policy shall contain a valid provision requiring notification to the Certificate Holder in the event any of the required policies be canceled or non-renewed or reduction in required coverage before the expiration date thereof.

- 2.7.1 Such notice shall reference the DEN assigned contract number related to this Agreement.
- 2.7.2 Said notice shall be sent thirty (30) days prior to such cancellation, non-renewal or reduction in coverage unless due to non-payment of premiums for which notice shall be sent ten (10) days prior.
- 2.7.3 If such written notice is unavailable from the insurer or afforded as outlined above, Contractor and/or its insurance broker/agent shall provide written notice of cancellation, non-renewal and any reduction in coverage to the Certificate Holder within seven (7) business days of receiving such notice by its insurer(s) and include documentation of the formal notice received from its insurer(s) as verification. Contractor shall replace cancelled or nonrenewed policies with no lapse in coverage and provide an updated Certificate of Insurance to DEN.
- 2.7.4 In the event any general aggregate or other aggregate limits are reduced below the required minimum per occurrence limits, Contractor will procure, at its own expense, coverage at the requirement minimum per occurrence limits. If Contractor cannot replenish coverage within ten (10) calendar days, it must notify the City immediately.

## 2.8 Cooperation

Contractor agrees to fully cooperate in connection with any investigation or inquiry and accept any formally tendered claim related to this Agreement, whether received from the City or its representative. Contractor's failure to fully cooperate may, as determined in the City's sole discretion, provide cause for default under the Agreement. The City understands acceptance of a tendered claim does not constitute acceptance of liability.

## 2.9 Additional Provisions

- 2.9.1 Deductibles or any type of retention are the sole responsibility of the Contractor.
- 2.9.2 Defense costs shall be in addition to the limits of liability. If this provision is unavailable that limitation must be evidenced on the Certificate of Insurance.
- 2.9.3 Coverage required may not contain an exclusion related to operations on airport premises.
- 2.9.4 A severability of interests or separation of insureds provision (no insured vs. insured exclusion) is included under any policy requiring Additional Insured status.
- 2.9.5 A provision that coverage is primary and non-contributory with other coverage or self-insurance maintained by DEN, excluding Professional Liability and Workers' Compensation policies, if required.

- 2.9.6 The insurance requirements under this Agreement shall be the greater of (i) the minimum limits and coverage specified hereunder or (ii) the broader coverage and maximum limits of coverage of any insurance policy or proceeds available to the Contractor. It is agreed that the insurance requirements set forth herein shall not in any way act to reduce coverage that is broader or that includes higher limits than the minimums set forth in this Agreement.
- 2.9.7 All policies shall be written on an occurrence form when available and industry norm. If an occurrence form is unavailable and/or the industry norm, claims-made coverage may be accepted by DEN provided the retroactive date is on or before the Agreement Effective Date or the first date when any goods or services were provided to DEN, whichever is earlier, and continuous coverage will be maintained or an extended discovery period of three years beginning at the time work under this Agreement is completed or the Agreement is terminated, whichever is later.
- 2.9.8 Certificates of Insurance must specify the issuing companies, policy numbers and policy periods for each required form of coverage. The certificates for each insurance policy are to be signed by an authorized representative and must be submitted to the City at the time Contractor signed this Agreement.
- 2.9.9 The insurance shall be underwritten by an insurer licensed or authorized to do business in the State of Colorado and rated by A.M. Best Company as A- VIII or better.
- 2.9.10 Certificate of Insurance and Related Endorsements: The City's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements shall not act as a waiver of Contractor's breach of this Agreement or of any of the City's rights or remedies under this Agreement. All coverage requirements shall be enforced unless waived or otherwise modified in writing by DEN Risk Management. Contractor is solely responsible for ensuring all formal policy endorsements are issued by their insurers to support the requirements.
- 2.9.11 The City shall have the right to verify, at any time, all coverage, information, or representations, and the insured and its insurance representatives shall promptly and fully cooperate in any such audit the City may elect to undertake including provision of copies of insurance policies upon request. In the case of such audit, the City may be subject to a non-disclosure agreement and/or redactions of policy information unrelated to the required coverage and premium amounts.
- 2.9.12 No material changes, modifications, or interlineations to required insurance coverage shall be allowed without the review and written approval of DEN Risk Management.
- 2.9.13 Contractor shall be responsible for ensuring the City is provided updated Certificate(s) of prior to each policy renewal.
- 2.9.14 Contractor's failure to maintain required insurance shall be the basis for immediate suspension and cause for termination of this Agreement, at the City's sole discretion and without penalty to the City.

2.10 Part 230 and the DEN Airport Rules and Regulations

If the minimum insurance requirements set forth herein differ from the equivalent types of insurance requirements in Part 230 of the DEN Airport Rules and Regulations, the greater and broader insurance requirements shall supersede those lesser requirements, unless expressly excepted in writing by DEN Risk Management.

**3. Insurance Requirements for ROCIP Enrolled Contractors and Subcontractors**

3.1 Insurance Provided by the DEN ROCIP

DEN retains the right to have this Project insured under a ROCIP. ROCIP coverage shall provide: (i) Commercial General Liability, (ii) Workers' Compensation & Employer's Liability, (iii) Excess Liability, (iv) Contractor's Pollution Liability, and (v) Builder's Risk as outlined herein and as defined by the respective policies for each coverage, for the period from the start of Work through completion and final acceptance by DEN except as otherwise provided herein.

### 3.2 Enrollment Required

Parties performing labor or services at the Project Site are eligible to enroll in the DEN ROCIP, unless they are Ineligible Parties (as defined in ROCIP Insurance Manual Section 4). Participation is mandatory but not automatic. Parties eligible for enrollment shall follow the procedures and follow the instructions as provided in the DEN ROCIP Insurance Manual to enroll in the program. When the Contractor and subcontractors of any tier are properly enrolled, the DEN ROCIP Administrator will issue a Certificate of Insurance evidencing the coverages afforded to each Enrolled Party under the DEN ROCIP, prior to their commencing Work on the Project Site.

### 3.3 Exclusion of Contractor/Subcontractor Insurance Costs from Proposal and Bid Prices

Contractor shall exclude from Contractor's cost of work and ensure that each subcontractor of any tier exclude from their cost of work, normal costs for insurance for those coverages provided under the DEN ROCIP. As part of the enrollment process, Contractor and subcontractors shall provide policy declaration rate pages and deductible endorsements on the General Liability, Workers' Compensation, and Excess Liability policies as required in the DEN ROCIP Insurance Manual. The calculation of these costs will be determined by the ROCIP Program Administrator. The costs of DEN ROCIP coverage includes reductions in insurance premiums, all relevant taxes and assessments, markup on insurance premiums, and losses retained through large deductibles, self-insured retentions, or self-funded programs. Change orders shall also exclude the cost of ROCIP coverage.

Pre-employment substance abuse testing costs will be covered by DEN and should be removed from bid prices. Drug testing will be more thoroughly discussed in the ROCIP Safety Manual.

### 3.4 Insurance Premiums

DEN will pay the insurance premiums for the DEN ROCIP insurance policies. DEN is responsible for all adjustments to the premiums and will be the sole beneficiary of all dividends, retroactive adjustments, return premiums, and any other monies due through audits or otherwise. The Contractor assigns to DEN the right to receive all such adjustments and will require that each subcontractor of any tier assign to DEN all such adjustments. The Contractor and the subcontractors who are Enrolled Parties shall execute such further documentation as may be required by DEN to accomplish this assignment.

### 3.5 Off Site Operations Coverage Under ROCIP

The DEN ROCIP will provide certain insurance coverage for DEN, Contractor and Enrolled Parties, along with their Eligible Employees performing Work at the Project Site. Off-site operations shall be covered only if designated in writing by DEN and when all operations at such site are identified and solely dedicated to the Project. Contractors and subcontractors are responsible to notify the DEN ROCIP Administrator in writing, to request coverage for specified off-site operations. Coverage is not provided at the off-site location unless confirmed in writing by the DEN ROCIP Administrator.

### 3.6 DEN ROCIP Insurance Manual

As soon as practicable, the DEN ROCIP Insurance Manual will be sent to each Enrolled Party and will become a part of the Contract and Contractor's Subcontract with its subcontractor and its subcontractors' agreements with any lower-tier subcontractor. The DEN ROCIP Insurance Manual will contain the administrative and claim reporting procedures. Contractor agrees to and will require that its subcontractors of any tier to cooperate with the DEN ROCIP Administrator in providing all required information.

### 3.7 Conflicts

Descriptions of the DEN ROCIP coverages set forth in ROCIP Insurance Manual Section 4.6 are not intended to be complete or meant to alter or amend any provision of the DEN ROCIP insurance policies. The DEN ROCIP coverages, terms, conditions, and exclusions are set forth in full in their respective policy forms. In the event of a conflict or omission between the coverages provided in the DEN ROCIP insurance policies and the coverages summarized or described in the DEN ROCIP Insurance Manual, this Exhibit or elsewhere in the Contract Documents, the DEN ROCIP insurance policies shall govern. In the event of a conflict between the provisions of this Exhibit and the DEN ROCIP Insurance Manual, that does not involve any conflict with the provisions of the DEN ROCIP insurance policies, the provisions of this Exhibit shall govern.

### 3.8 ROCIP Insurance Coverage Provided to Enrolled Parties

#### 3.8.1 Insurance Provided by DEN

Unless otherwise provided herein, prior to commencement of the Work, DEN, at its sole option and expense, shall secure and maintain at all times during the performance of this Contract the insurance specified below, insuring DEN, Enrolled Parties and such other persons or interests as DEN may designate with limits not less than those specified below for each coverage.

##### 3.8.1.1 Workers' Compensation & Employer's Liability – On Site Only

DEN shall maintain the coverage as required by statute for the Project Site and shall maintain Employer's Liability insurance with limits no less than \$1,000,000 per occurrence for each bodily injury claim, \$1,000,000 per occurrence for each bodily injury caused by disease claim, and \$1,000,000 aggregate for all bodily injuries caused by disease claims.

##### 3.8.1.2 Commercial General Liability – On Site Only

DEN shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, and products and completed operations in minimum limits as listed below:

Coverage	Limit
Annual General Aggregate (Per Project and Reinstates Annually)	\$4,000,000
Products/Completed Operations Aggregate (Per Project and Statute of Repose)	\$4,000,000
Total Products/Completed Operations Aggregate (Statute of Repose)	\$20,000,000
Personal / Advertising Injury Limit	\$2,000,000
Each Occurrence Limit	\$2,000,000
Fire Damage Legal Liability (any one fire)	\$ 300,000
Medical Payments (any one person)	\$ 10,000

##### 3.8.1.3 Excess Liability Insurance

DEN shall maintain coverage following form with underlying policies of Commercial General Liability and Employer's Liability in minimum limits as listed below:

Coverage	Limit
Annual General Aggregate (Per Project and Reinstates Annually)	\$200,000,000
Products/Completed Operations Aggregate (Per Project)	\$20,000,000
Total Products/Completed Operations Aggregate (Policy Cap)	\$400,000,000
Each Occurrence Limit	\$200,000,000

DEN, in its sole discretion, may elect to provide higher limits, based on Project size. Excess Liability limits are shared by all Insured parties.

#### 3.8.1.4 Contractor's Pollution Liability

DEN shall maintain coverage for bodily injury, property damage, or environmental damage caused by a pollution event resulting from covered operations, including completed operations, at the Project Site with a limit no less than \$10,000,000 each occurrence and aggregate. Coverage includes microbial matter and legionella pneumophila in any structure on land and the atmosphere contained with the structure. Products/Completed Operations coverage may extend for the statute of limitations/repose after final completion of the Project.

#### 3.8.1.5 Builder's Risk Insurance

DEN shall maintain, Builder's Risk (and/or Installation Floater) in the amount of \$200,000,000 per occurrence subject to various sublimits (as defined in the Builders' Risk Policy). Such insurance shall end when the first of the following occurs: 1) DEN's interest in the Work ceases; 2) the policy expires or is cancelled; or 3) the Work is accepted by DEN.

Builder's Risk Insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss of damage including , theft, vandalism, malicious mischief, terrorism, rigging and hoisting for materials and equipment that are part of the Project, collapse, earthquake, flood, windstorm, falsework, testing and startup (as provided by the policy), temporary buildings and debris removal including demolition occasioned by enforcement of any applicable ordinance laws, and shall cover reasonable compensation for services and expenses required as a result of such insured loss.

This Builder's Risk Insurance shall cover portions of the Work stored off site, and also portions of the Work in transit.

DEN and Contractor shall waive all rights against (1) each other and any of their subcontractors of any tier, and all respective agents and employees, and (2) the architect, architect's consultants, separate contractors, if any, and any of their subcontractors of any tier, and all respective agents and employees, for damages caused by fire or other causes of loss to the extent covered by Builder's Risk Insurance obtained pursuant to this Section or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by DEN as fiduciary. DEN or Contractor, as appropriate, shall require of the architect, architect's consultants, separate contractors, and their subcontractors of any tier, and all respective agents and employees, by appropriate agreements, written where

legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

3.8.2 Claim Chargeback

A claim charge-back will be assessed, regardless of fault, for the amount of any loss payable under this program with the exception of Workers' Compensation and Excess Liability, up to a maximum of \$25,000 each loss. General Contractor may elect to pass no more than \$5,000 of this charge, each loss, through to any responsible subcontractor.

3.9 Other Insurance Provided By Enrolled Parties

At their own expense, the Enrolled Parties of all tiers must carry the following minimum coverage and limits and such insurance shall be evidenced to DEN and the DEN ROCIP Administrator as required in this Section 3.9.

3.9.1 Certificate Holder

Certificate(s) shall be issued to: CITY AND COUNTY OF DENVER  
Denver International Airport  
8500 Peña Boulevard, Suite 8810  
Denver CO 80249  
Attn: Risk Management

and

CITY AND COUNTY OF DENVER  
Department of Aviation  
c/o Marsh USA, Inc.  
111 SW Columbia, Ste 500  
Portland, OR 97201

3.9.2 Acceptable Certificate of Insurance Form and Submission Instructions

Please read these requirements carefully to ensure proper documentation and receipt of your certificate(s) of insurance.

- ACORD FORM (or equivalent) certificate is required.
- SUBMIT via emailed in pdf format to: contractadmininvoices@flydenver.com and DenverAirport.ROCIP@marsh.com
- ELECTRONIC CERTIFICATES are required, hard copy documents will not be accepted.
- THIRD PARTY SOFTWARE may be implemented during the term of this Agreement to manage insurance compliance and documents with required use by Vendor of such system.
- REFERENCE on the certificate must include the DEN assigned Contract Number.

3.9.3 Other Insurance Requirements

Enrolled Contractors shall adhere to the same minimum insurance requirements as stated in Section 2 of this exhibit, with the following exceptions:

- Commercial General Liability coverage requirement is Off Site Only

- Workers' Compensation and Employer's Liability coverage requirement is Off Site Only
- Contractor's Pollution Legal Liability is not required

#### **4. Contractor Warranties and Agreements**

##### **4.1 Accuracy of Contractor-provided Information**

Contractor warrants that all information submitted to DEN or the DEN ROCIP Administrator is accurate and complete to the best of its knowledge. Contractor will notify DEN or the DEN ROCIP Administrator immediately in writing of any errors discovered during the performance of the Work.

##### **4.2 Contractor Responsible to Review Coverage**

Contractor acknowledges that all references to DEN ROCIP policy terms, conditions, and limits of liability in this document, as well as the DEN ROCIP Insurance Manual, are for reference only. Contractor and its subcontractors of any tier are responsible for conducting their own independent review and analysis of the DEN ROCIP insurance policies in formulating any opinion or belief as to the applicability of such coverage in the event of any loss or potential claim. Any type of insurance or increase of limits not described above, which the Contractor requires for its own protection or on account of statute, shall be its own responsibility and at its own expense.

##### **4.3 Audit**

Contractor agrees to make its records available for review and to cooperate with DEN, its insurers and insurance brokers, the City Auditor, and representatives of the aforesaid parties in the event of an audit. In the event that a DEN audit of Contractor's records, as permitted in the Contract or other DEN ROCIP documents, reveals a discrepancy in the insurance, payroll, safety, or any other information required to be provided to DEN or the DEN ROCIP Administrator, or reveals inclusion of costs for DEN ROCIP coverage or other coverage beyond what is described above in any payment for the Work, DEN will have the right to deduct from payments due Contractor all such insurance costs as well as all audit costs.

##### **4.4 Insurance Costs Removed**

Contractor warrants that the costs for insurance as provided under the DEN ROCIP were not included in Contractor's bid or proposal for the Work, the Contract Price/Contract Sum, and will not be included in any change order or any request for payment for the Work or extra work.

#### **5. Contractor Obligations**

##### **5.1 ROCIP Documents Shall be Provided to Subcontractor**

Contractor shall furnish each bidding subcontractor, vendor, supplier, material dealer or other party a copy of this Exhibit, the DEN ROCIP Insurance Manual and the DEN ROCIP Safety Manual and shall incorporate the terms of this Exhibit in all contracts and agreements entered into for performance of any portion of the Work.

##### **5.2 Timely Enrollment Required**

Contractor shall enroll in the DEN ROCIP within five (5) business days following a request by DEN or the DEN ROCIP Administrator. Contractor shall notify each subcontractor of the process for enrolling in DEN ROCIP and confirm that enrollment is mandatory, but not automatic. Contractor shall assure that subcontractors of any tier shall not commence Work until verification of enrollment is confirmed by the DEN ROCIP Administrator by the issuance of a Certificate of Insurance to each individual Enrolled Party.

### 5.3 Compliance with Conditions

Contractor shall not violate any condition of the policies of insurance provided by DEN under the terms of this Exhibit, the DEN ROCIP Insurance Manual or the DEN ROCIP Safety Manual. All requirements imposed by the subject policies and to be performed by Contractor shall likewise be imposed on, assumed, and performed by each subcontractor of any tier.

### 5.4 Claims Cooperation

Contractor shall participate in claim reporting procedures. Contractor agrees to assist and cooperate in every manner possible in connection with the adjustment of all claims arising out of operations within the scope of the Work required by the Contract, and to cooperate with DEN's insurer(s) in all claims and demands which DEN's insurer(s) is called upon to adjust or to defend against. Contractor shall take all necessary action to assure that its subcontractors of any tier comply with any request for assistance and cooperation. This obligation includes, without limitation, providing light or modified duty for injured workers, appearing in mediation, arbitration, or court proceedings and/or participating in settlement meetings, as may be required.

### 5.5 Monthly Payroll Submission

All Enrolled Parties shall submit monthly payrolls and worker-hour reports to DEN and/or the DEN ROCIP Administrator via the DEN ROCIP Administrator's online reporting system as outlined in the DEN ROCIP Insurance Manual. The online reporting instructions will be provided to all Contractors at time of enrollment. Failure to submit these reports may result in funds being held or delayed from monthly progress payments. Payroll must be submitted online for each month, including zero (0) payroll, if applicable, until completion of the Work under each Contract and Subcontract. For subcontractors of any tier performing Work under multiple Subcontracts, a separate payroll report is required for each Subcontract under which Work is being performed.

### 5.6 Response to Information Requests

All insurance underwriting, payroll, rating or loss history information requested by DEN or the DEN ROCIP Administrator shall be provided by the Contractor within three (3) business days of request. Contractor agrees (and will require each subcontractor to agree) that DEN, DEN's insurers or its representative may audit the Contractor's records or records of subcontractors of any tier to confirm the accuracy of all insurance information provided including, without limitation, any such information that may have any effect on insurance resulting from changes in the Work. At all times during performance of the Contract and Subcontracts, the Contractor and subcontractors of any tier shall cooperate with DEN, the DEN ROCIP Administrator and DEN's insurers.

### 5.7 Responsibility for Safety

Notwithstanding the DEN ROCIP, the Contractor shall initiate, maintain, and supervise all safety precautions and programs in connection with the Work. Contractor is solely responsible, at no adjustment to the contract sum payable or contract time, for initiating, maintaining, and supervising all safety precautions and programs relating to the conduct of Work including, without limitation, any safety programs or procedures that are required by any applicable state or federal laws, rules or regulations, or under the terms of the DEN ROCIP Safety Manual.

### 5.8 Duty of Care

Nothing herein shall relieve the Enrolled Parties of their respective obligations to exercise due care in the performance of their duties in connection with the Work or to complete the Work in strict compliance with this Contract and subsequent subcontracts.

## 6. Notices and Costs

### 6.1 Limitations on DEN Provided Coverage and DEN Right to Purchase Other Coverage

DEN assumes no obligations to provide insurance other than that evidenced by the policies referred to in Section 3.8. DEN, however, reserves the right to furnish insurance coverage of various types and limits provided that such coverage shall not be less than that specified in Section 3.8 and the costs of such insurance shall be paid by DEN. Apart from the DEN ROCIP, DEN may at its option purchase additional insurance coverages that insure the Project that may not necessarily insure the Contractor or the subcontractors. Without limitation, examples of such coverage may include pollution liability, excess professional liability, and excess automobile liability insurance.

### 6.2 Contractors Responsible for Own Equipment

Contractor and subcontractors are solely responsible for loss or damage of all construction tools and other equipment whether owned, leased, rented, borrowed, or used on Work at the Project Site. If an individual Enrolled Party purchases insurance on their tools and equipment, such insurance shall contain a waiver of subrogation in favor of the City and County of Denver, its elected and appointed officials, agents, employees and volunteers and all other Enrolled Parties. If an individual Enrolled Party does not purchase such insurance, that Enrolled Party will hold harmless the City and County of Denver, its elected and appointed officials, agents, employees and volunteers and other Enrolled Parties for loss or damage to its tools and equipment.

### 6.3 No Release; No Waiver of Immunity

The provision of the DEN ROCIP shall in no way be interpreted as relieving Contractor or subcontractors of any tier of any responsibility or liability under the Contract Documents, the DEN ROCIP insurance policies or applicable laws including, without limitation, Contractor's and subcontractor's responsibilities relative to indemnification and their obligation to exercise due care in the performance of the Work and to complete the Work in strict compliance with the Contract Documents. The parties hereto understand and agree that the City and County of Denver, its elected and appointed officials, agents, employees and volunteers are relying on, and do not waive or intend to waive by any provisions of this agreement, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, §§ 24-10-101 to 120, C.R.S., or otherwise available to DEN, its officers, officials and employees.

### 6.4 DEN Right to Withhold Payments

In addition to any other rights of withholding that DEN may have under the Contract Documents, DEN has the right to withhold any payments otherwise due to Contractor in the event of a failure by Contractor or any subcontractor to comply with the requirements of this Exhibit, the DEN ROCIP Insurance Manual or the DEN ROCIP Safety Manual. DEN may withhold from any payment owing to Contractor the costs of DEN ROCIP coverages if included in a request for payment. Such withholding by DEN shall not be deemed to be a default under the Contract. DEN shall withhold from Contractor the costs of DEN ROCIP coverages attributable to an increase in an Enrolled Party's total payroll for the Work over the amount reported to DEN and/or the DEN ROCIP Administrator at time of enrollment.

### 6.5 DEN Remedies

Without limitation upon any of DEN's other rights or remedies, any failure of an Enrolled Party to comply with any provision of this Exhibit, the DEN ROCIP Insurance Manual, or the DEN ROCIP Safety Manual shall be deemed a material breach of the Contract, thereby entitling DEN, at its option, upon notice to Contractor, to (1) suspend performance by Contractor and/or the offending subcontractor, without any adjustment to Contract Sum Payable or Contract Time, until there is full compliance, or (2) terminate this Contract for cause.

## 6.6 Off Site Storage

Unless otherwise provided in the Contract Documents, the property insurance provided by DEN shall not cover portions of the Work stored off the Site without written approval of DEN. Contractor shall be responsible for reporting such property or work if ownership has been transferred to DEN. If ownership rests with the Contractor, Contractor shall be responsible for obtaining insurance to protect its interests.

## 6.7 Partial Occupancy

Partial occupancy or use shall not commence until DEN insurer(s) providing Builders Risk and/or Property Insurance have consented to such partial occupancy or use by endorsement or otherwise. DEN and the Contractor shall take reasonable steps to obtain consent of the insurer(s) and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

## 6.8 DEN Right to Exclude Parties from the DEN ROCIP

DEN reserves the right to exclude any subcontractor from the DEN ROCIP, before or after enrollment by the subcontractor. If DEN elects to exclude a subcontractor from the DEN ROCIP, the Contractor will be responsible for ensuring the insurance coverages outlined in the Contractor's Subcontract Agreement are provided to DEN or the DEN ROCIP Administrator before the subcontractor can begin or resume Work on the Project.

## 6.9 DEN's Right to Modify or Discontinue DEN ROCIP Coverages

If DEN determines that modification or discontinuation of the DEN ROCIP is in the best interest of DEN, the Contractor and subcontractor will receive sixty (60) days advance written notice to secure and maintain such insurance as is required to provide replacement coverage comparable to that provided under the DEN ROCIP. Provided that the foregoing is not the result of any failure by the Contractor or any subcontractor to comply with the requirements of the Contract Documents, the DEN ROCIP Insurance Manual or DEN ROCIP Safety Manual, the costs of such replacement insurance shall be deemed a cost of Work for which the Contractor shall be entitled to a Contract Adjustment, without any sum added thereto for Allowable Markup. The form, content, limits of liability, cost and the rating of the insurer(s) issuing such replacement coverage shall be subject to DEN's prior written approval.

## 7. Definitions

Certificate of Insurance:	A document providing evidence of coverage for a particular insurance policy or policies. This will include certificates issued to Enrolled Parties evidencing the coverage afforded under the DEN ROCIP and certificates issued to DEN evidencing additional coverage "Provided by Enrolled Parties"
DEN:	City and County of Denver and Denver International Airport
Contract:	The written agreement between DEN and Contractor describing the Work, contract terms and conditions, or a portion thereof; also includes a written agreement between a Contractor and any subcontractor as well as between subcontractors and their subcontractors of any tier.
Contractor Insurance Cost:	The costs of ROCIP coverage are defined as the amount of Contractor's and eligible Subcontractors' of every tier reduction in insurance costs due to participation in the DEN ROCIP.

Rolling Owner Controlled Insurance Program (ROCIP): A coordinated insurance program providing certain coverage, as defined herein, for DEN, Contractor and Enrolled Subcontractors, along with their Eligible Employees, performing Work at the Project Site.

Eligible Employees: Employees of the Contractor and Enrolled Subcontractors who are not excluded from the ROCIP under the “Excluded Parties” definition.

Enrolled Parties: The Contractor and those subcontractors that have submitted all necessary enrollment information and been accepted into the ROCIP as evidenced by the issuance of a Certificate of Insurance.

Ineligible/Excluded Parties: Parties not covered by the ROCIP because of ineligibility or DEN explicit exclusion. No insurance coverage provided by DEN under the ROCIP shall extend to the activities or products of the following:

- Any person or organization that fabricates or manufactures products, materials or supplies away from a Project Site with no direct onsite installation responsibility

Exception: The ROCIP Insurer may agree to extend General Liability coverage only if the General Contractor has a written contract with the off-site fabricator or manufacturer to provide the pre-fabricated product. To consider extending coverage, the Insurer requires 30 days advance written notice to the ROCIP Administrator with details of the work/product and a copy of the contract between the General Contractor and the off-site fabricator or manufacturer. Approval must be obtained from the Insurer before enrolling in the ROCIP for General Liability coverage only.

- Scaffolding contractors (erecting and dismantling scopes of work only)
- Hazardous materials remediation, removal, or transportation companies and their consultants
- Architects, engineers, surveyors and their consultants
- Truckers, haulers, material dealers, vendors, suppliers, and others who merely transport, pick up, deliver, or carry materials, personnel, parts or equipment or any other items or persons to or from a Project Site including companies providing supplemental services
- Contractors, subcontractors and subconsultants who do not work at a Project Site
- Employees of an Enrolled Party who either (i) do not work on-site or (ii) occasionally visit a Project Site to make deliveries, pick-up supplies or personnel, to perform supervisory or progress inspections, or for any other reason

- Temporary labor employees (individuals working directly for the Contractor and not procured through a third party such as a Professional Employer Organization)

Exception: The ROCIP Insurer typically will accept including employees working for a contractor, or employed by temporary staffing agencies or professional employer organizations, as long as those employer-entities are enrolled as subcontractors to supply supplemental workforce.

Insured: (liability policies)	DEN, Contractor and Enrolled Parties and their Eligible Employees and any other party named in the insurance policies.
Insurers:	Those insurance companies providing the DEN ROCIP coverage. The insurers will be identified on the issued Certificate of Insurance and in the DEN ROCIP Insurance Manual.
Net Bid:	Contractor bids with insurance costs removed because of the obligation of any Enrolled Party to delete insurance costs for coverage provided by the ROCIP from its bid and all change orders. Net bids are subject to verification by the Administrator through the providing of contractors' rate and declaration pages from their Insurance policies.
ROCIP Administrator:	The DEN ROCIP Administrator will be identified in the DEN ROCIP Insurance Manual.
ROCIP Insurance Manual:	A reference document provided to Contractor and subcontractors of all tiers, which summarizes the terms and provisions of the DEN ROCIP and provides information about requirements and compliance.
ROCIP Safety Manual:	A reference document provided to Contractor and subcontractors of all tiers which contains workplace safety requirements of all Enrolled Parties.
Off Site Work:	Work performed away from the Project Site.
Payroll:	For purposes of the ROCIP only, refers to Unburdened Straight Time Payroll per Workers Compensation Class Code.
Policy Owner:	City and County of Denver and Denver International Airport
Project:	The Project as defined in the contract documents and as described in the Declarations of the DEN ROCIP insurance policies.

**Project Site:** Means those areas designated in writing by DEN in a Contract document for performance of the Work and such additional areas as may be designated in writing by DEN for Contractors' use in performance of the Work. Subject to the ROCIP Insurer(s) written approval, the term "Project Site" shall also include: (1) field office sites, (2) property used for bonded storage of material for the Project approved by DEN, staging areas dedicated to the Project, and (4) areas where activities incidental to the Project are being performed by Contractor or subcontractors covered by the DEN ROCIP Worker's Compensation policy (if included), but excluding any permanent locations of any Enrolled Party.

*Items 1 through 4 above must be approved by the ROCIP Insurer and listed on the DEN ROCIP insurance policies.*

**Subcontract:** The written agreement between Contractor and subcontractor, or between subcontractor and a lower tier subcontractor, describing the Work, subcontract terms and conditions, or a portion thereof.

**Subcontractor:** Includes those persons, firms, joint venture entities, corporations, or other parties that enter into a Subcontract with Contractor to perform Work at the Project Site and any of these subcontractor's lower-tier subcontractors.

**Work:** Operations, as fully described in the Contract and Subcontract, performed at the Project Site.



**TO:** All Users of the City and County of Denver Prevailing Wage Schedules  
**FROM:** Alex Marvin, Classification and Compensation Analyst Staff  
**DATE:** January 20, 2023  
**SUBJECT:** Latest Change to Prevailing Wage Schedules

The effective date for this publication will be **Friday, January 6, 2023**, and applies to the City and County of Denver for **HIGHWAY CONSTRUCTION PROJECTS** in accordance with the Denver Revised Municipal Code, Section 20-76(c).

General Wage Decision No. CO20230009  
Superseded General Decision No. CO20220009  
Modification No. 0  
Publication Date: 01/06/2023  
(6 pages)

Unless otherwise specified in this document, apprentices shall be permitted only if they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor (DOL). The employer and the individual apprentice must be registered in a program which has received prior approval by the DOL. Any employer who employs an apprentice and is found to be in violation of this provision shall be required to pay said apprentice the full journeyman scale.

Attachments as listed above.

**\*Career Service Board approved to adjust all Davis Bacon classifications under \$17.29 to comply with the city's minimum wage. The effective date is January 1, 2023. See page 7 for reference.**

Office of Human Resources  
201 W. Colfax Ave. Dept. 412 | Denver, CO 80202  
p: 720.913.5751 | f: 720.913.5720  
[www.denvergov.org/humanresources](http://www.denvergov.org/humanresources)

"General Decision Number: CO20230009 01/06/2023

Superseded General Decision Number: CO20220009

State: Colorado

Construction Type: Highway

Counties: Denver and Douglas Counties in Colorado.

HIGHWAY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract.  . The contractor must pay all covered workers at least \$16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract.  . The contractor must pay all covered workers at least \$12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this



(3)-Loader (under 6 cu. yd.) Denver County.....	\$ 31.05	12.35
(3)-Motor Grader (blade-rough) Douglas County.....	\$ 31.05	12.35
(4)-Crane (50 tons and under), Scraper (single bowl, under 40 cu. yd).....	\$ 31.70	12.35
(4)-Loader (over 6 cu. yd) Denver County.....	\$ 31.20	12.35
(5)-Drill Rig Caisson (Watson 2500 similar or larger), Crane (51-90 tons), Scraper (40 cu.yd and over),.....	\$ 31.37	12.35
(5)-Motor Grader (blade-finish) Douglas County.....	\$ 31.37	12.35
(6)-Crane (91-140 tons).....	\$ 33.05	12.35

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SUCO2011-004 09/15/2011

	Rates	Fringes
CARPENTER (Excludes Form Work)....	\$ 19.27	5.08
CEMENT MASON/CONCRETE FINISHER		
Denver.....	\$ 20.18	5.75
Douglas.....	\$ 18.75	3.00
ELECTRICIAN (Excludes Traffic Signal Installation).....	\$ 35.13	6.83
FENCE ERECTOR (Excludes Link/Cyclone Fence Erection).....	\$ 13.02 **	3.20
GUARDRAIL INSTALLER.....	\$ 12.89 **	3.20
HIGHWAY/PARKING LOT STRIPING:Painter		
Denver.....	\$ 12.62 **	3.21
Douglas.....	\$ 13.89 **	3.21
IRONWORKER, REINFORCING (Excludes Guardrail Installation).....	\$ 16.69	5.45
IRONWORKER, STRUCTURAL (Includes Link/Cyclone Fence Erection, Excludes Guardrail Installation).....	\$ 18.22	6.01

## LABORER

Asphalt Raker.....	\$ 16.29	4.25
Asphalt Shoveler.....	\$ 21.21	4.25
Asphalt Spreader.....	\$ 18.58	4.65
Common or General		
Denver.....	\$ 16.76	6.77
Douglas.....	\$ 16.29	4.25
Concrete Saw (Hand Held)....	\$ 16.29	6.14
Landscape and Irrigation....	\$ 12.26 **	3.16
Mason Tender- Cement/Concrete		
Denver.....	\$ 16.96	4.04
Douglas.....	\$ 16.29	4.25
Pipelayer		
Denver.....	\$ 13.55 **	2.41
Douglas.....	\$ 16.30	2.18
Traffic Control (Flagger)....	\$ 9.55 **	3.05
Traffic Control (Sets Up/Moves Barrels, Cones, Install Signs, Arrow Boards and Place Stationary Flags) (Excludes Flaggers).....	\$ 12.43 **	3.22
PAINTER (Spray Only).....	\$ 16.99	2.87
POWER EQUIPMENT OPERATOR:		
Asphalt Laydown		
Denver.....	\$ 22.67	8.72
Douglas.....	\$ 23.67	8.47
Asphalt Paver		
Denver.....	\$ 24.97	6.13
Douglas.....	\$ 25.44	3.50
Asphalt Roller		
Denver.....	\$ 23.13	7.55
Douglas.....	\$ 23.63	6.43
Asphalt Spreader.....	\$ 22.67	8.72
Backhoe/Trackhoe		
Douglas.....	\$ 23.82	6.00
Bobcat/Skid Loader.....	\$ 15.37 **	4.28
Boom.....	\$ 22.67	8.72
Broom/Sweeper		
Denver.....	\$ 22.47	8.72
Douglas.....	\$ 22.96	8.22
Bulldozer.....	\$ 26.90	5.59
Concrete Pump.....	\$ 21.60	5.21
Drill		
Denver.....	\$ 20.48	4.71
Douglas.....	\$ 20.71	2.66
Forklift.....	\$ 15.91 **	4.68
Grader/Blade		

Denver.....	\$ 22.67	8.72
Guardrail/Post Driver.....	\$ 16.07 **	4.41
Loader (Front End)		
Douglas.....	\$ 21.67	8.22
Mechanic		
Denver.....	\$ 22.89	8.72
Douglas.....	\$ 23.88	8.22
Oiler		
Denver.....	\$ 23.73	8.41
Douglas.....	\$ 24.90	7.67
Roller/Compactor (Dirt and Grade Compaction)		
Denver.....	\$ 20.30	5.51
Douglas.....	\$ 22.78	4.86
Rotomill.....	\$ 16.22	4.41
Screed		
Denver.....	\$ 22.67	8.38
Douglas.....	\$ 29.99	1.40
Tractor.....	\$ 13.13 **	2.95

## TRAFFIC SIGNALIZATION:

## Groundsman

Denver.....	\$ 17.90	3.41
Douglas.....	\$ 18.67	7.17

## TRUCK DRIVER

## Distributor

Denver.....	\$ 17.81	5.82
Douglas.....	\$ 16.98	5.27

## Dump Truck

Denver.....	\$ 15.27 **	5.27
Douglas.....	\$ 16.39	5.27

Lowboy Truck.....	\$ 17.25	5.27
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Mechanic.....	\$ 26.48	3.50
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Multi-Purpose Specialty &  
Hoisting Truck

Denver.....	\$ 17.49	3.17
Douglas.....	\$ 20.05	2.88

## Pickup and Pilot Car

Denver.....	\$ 14.24 **	3.77
Douglas.....	\$ 16.43	3.68

Semi/Trailer Truck.....	\$ 18.39	4.13
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Truck Mounted Attenuator.....	\$ 12.43 **	3.22
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## Water Truck

Denver.....	\$ 26.27	5.27
Douglas.....	\$ 19.46	2.58

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WELDERS - Receive rate prescribed for craft performing  
operation to which welding is incidental.

**Office of Human Resources  
Supplemental Rates  
(Specific to the Denver Projects)  
Revised 01/01/2023)**

<b>Classification</b>		<b>Base</b>	<b>Fringe</b>
Guard Rail Installer		\$17.29	\$3.20
Highway Parking Lot Striping: Painter		\$17.29	\$3.21
Ironworker (Ornamental)		\$26.05	\$12.00
Laborer	Removal of Asbestos	\$21.03	\$8.55
Laborer (Landscape & Irrigation)		\$17.29	\$3.16
Laborer: Traffic Control (Flagger)		\$17.29	\$3.05
Laborer: Stationary Flags (excludes Flaggers)		\$17.29	\$3.22
Line Construction	Lineman, Gas Fitter/Welder	\$36.88	\$9.55
	Line Eq Operator/Line Truck Crew	\$25.74	\$8.09
Millwright		\$28.00	\$10.00
Pipefitter		\$30.45	\$12.85
Plumber		\$30.19	\$13.55
Power Equipment Operator (Tunnels Above and Below Ground, shafts and raises):	Group 1	\$25.12	\$10.81
	Group 2	\$25.47	\$10.85
	Group 3	\$25.57	\$10.86
	Group 4	\$25.82	\$10.88
	Group 5	\$25.97	\$10.90
	Group 6	\$26.12	\$10.91
	Group 7	\$26.37	\$10.94
Power Equipment Operator	Group 1	\$22.97	\$10.60
	Group 2	\$23.32	\$10.63
	Group 3	\$23.67	\$10.67
	Group 4	\$23.82	\$10.68
	Group 5	\$23.97	\$10.70
	Group 6	\$24.12	\$10.71
	Group 7	\$24.88	\$10.79
Truck Driver	Group 1	\$18.42	\$10.00
	Group 2	\$19.14	\$10.07
	Group 3	\$19.48	\$10.11
	Group 4	\$20.01	\$10.16
	Group 5	\$20.66	\$10.23
	Group 6	\$21.46	\$10.31
Truck Driver: Truck Mounted Attenuator		\$17.29	\$3.22

Go to <http://www.denvergov.org/Auditor> to view the Prevailing Wage Clarification Document for a list of complete classifications used.

**EXHIBIT E**  
**SPECIAL CONDITIONS**

**V. SPECIAL CONDITIONS****SC-1 CONSTRUCTION CONTRACT GENERAL CONDITIONS**

The Construction Contract General Conditions which constitute a part of the Contract Documents are set forth in a separately published document, entitled "City and County of Denver, Department of Aviation and Department of Public Works, Standard Specifications for Construction, General Contract Conditions," 2011 Edition, the Table of Contents to which is bound herein (which may be informally referred to as the Yellow Book). The General Conditions book is available for purchase for \$12.00 per copy at the following locations during the business hours stated, Monday through Friday, excluding holidays:

Office of the Cashier  
Wellington E. Webb Municipal Office Building, 2nd Floor  
201 West Colfax Avenue  
Denver, Colorado, USA 80202  
7:30 a.m. to 4:30 p.m.

The General Conditions are also available on the City and County of Denver website at:

<https://www.denvergov.org/content/denvergov/en/contract-administration/contractor-resources/general-contract-conditions.html>

**SC-2 DRAWINGS AND SPECIFICATIONS TO BE FURNISHED BY THE CITY**

The City will provide the following Contract Documents to the Contractor in electronic format at no expense to the Contractor:

1. TW DS East IFB Plan Drawings (IFB Dated 1/23/23)
2. TW DS East IFB Volume 1, Division 1 Specifications (Dated 1/23/23)
3. TW DS East IFB Volume 2, Technical Specifications (Dated 1/23/23)
4. TW DS East IFB Construction Safety and Phasing Plan (Dated 1/23/23)

Additional copies of the foregoing documents will be furnished to the Contractor at the Contractor's expense. The Contractor will be responsible for supplying all subcontractors with copies of the Contract Documents at its expense.

If Sensitive Security Information ("SSI") is provided to the Contractor, the Contractor shall be required to comply with Department of Aviation, Standard Policies and Procedures No. 6003, "Contractor Protection of Sensitive Security Information," or its successor, and 49 C.F.R. § 1520, or its successor.

The City will not supply any copies of the General Contract Conditions to the Contractor at City expense.

**SC-3 REVISIONS TO G.C. 201**

The second sentence of General Condition 201 is amended to read: "The unit responsible for this management and control is the Airport Infrastructure Management Office under the supervision of the Senior Vice President for Maintenance and Airport Infrastructure Management."

**SC-4 CITY LINE OF AUTHORITY AND CONTACTS**

In accordance with General Condition 214, the City's line of authority for administration of this Contract is: Chief Executive Officer (CEO). Executive Office, 9th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249. Any reference to the Manager of Aviation shall also mean Chief Executive Officer, Department of Aviation (CEO).

Executive Vice President – Chief Construction and Infrastructure Officer (EVP-CCIO) who reports to the CEO. Airport Infrastructure Management office, 9th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Senior Vice President - Airport Infrastructure Management (SVP-AIM) who reports to the COO. Airport Infrastructure Management office, 10th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Director of Infrastructure and Quality Assurance, reports to the SVP-AIM. The Project Manager reports to the Director of Infrastructure and Quality Assurance. Airport Infrastructure Management Division, 7<sup>th</sup> Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Project Manager, the City representative who has day to day administrative responsibility of this Contract, and who reports to the SVP-AIM. All notices, requests, pay applications (pursuant to G.C. 902), and other correspondence from the Contractor shall be sent to the assigned Project Manager unless otherwise provided in this Contract. The Project Manager for this Contract is: Chris Unzicker, Airport Infrastructure Management Office, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249, phone 303-342-2200.

The CEO may from time to time substitute a different City official as the designated “SVP-AIM” hereunder, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor SVP-AIM. The SVP-AIM may from time to time change the assigned Project Manager, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor Project Manager.

#### **SC-5 CONTRACTOR PERFORMANCE; SUBCONTRACTING**

With respect to General Condition 501, no more than sixty percent (60%) of the work may be subcontracted. If it is determined to be in the City’s best interest, this percentage may be modified throughout the course of the project by the SVP-AIM.

#### **SC-6 COOPERATION WITH OTHERS**

The Technical Specifications describe the constraints on the physical work site areas. These descriptions are not exhaustive, and the Contractor is required to coordinate its activities and work as may be required to meet FAA or City requirements while performing work on DEN.

Without limiting the foregoing, the following contracts administered by the City involve or may involve work overlapping or adjoining the Work under this Contract and may be prosecuted concurrently with the Work performed under this Contract. There may also be other adjoining or overlapping contracts which are not listed.

<u>Contract Number</u>	<u>Description</u>
201952248	Runway 17L-35R Complex Rehabilitation
TBD	Concourse C C40-/C42 Rehabilitation
202158849	Taxiway EE
202263079	West Gates DIW Expansion

#### **SC-7 PROSECUTION AND COMPLETION OF THE WORK:**

The Work to be performed under the Contract is described in the Technical Specifications and Contract Drawings. The Contractor shall complete the Work within 411 consecutive calendar days from Notice to Proceed.

The Work to be performed under the Contract may be divided into the Milestone Areas which are described in

the Technical Specifications or Contract Drawings. The Contractor shall complete the work included within these areas within the number of days set forth by the Project Manager.

#### **SC-8 LIQUIDATED DAMAGES**

If the Contractor fails to achieve Substantial Completion of the Work within each phase or the overall Contract Time, the Contractor shall be liable to the City for liquidated damages at the rate of Seven Thousand, Five Hundred Dollars (\$7,500.00) per day until substantial completion is achieved for that phase and/or overall Contract Term.

Article IV of the Contract and General Condition 602 cover payment and withholding of liquidated damages.

#### **SC-9 FACILITY SECURITY AND PERSONNEL ACCESS**

The Contractor shall conduct all its activities at the Airport in compliance with the Airport security system rules and regulations, which are administered by the Airport Operations Division. The Contractor shall obtain the proper access authorizations for its employees, subcontractors, and suppliers (i.e., Badges and Permits), and shall be responsible for such persons' compliance with all the Airport rules and regulations. A copy of the Contractors' section of the Airport Security rules and regulations are available for Contractor review at the Airport Access Services Office, Concourse A East Subcore, 4th Level. Persons regularly entering the construction areas must obtain personnel access badges from the Airport Access Services Office and must display badges, at all times, upon entering the construction, restricted and sterile areas of the airport. Any employee, subcontractor or supplier who violates such rules may be subject to revocation of his access authorization, including authorization for access to the construction site and all other restricted and sterile areas.

The security status of the Airport is subject to change without notice. These contract Special Conditions are applicable to the current security status of the Airport. Should the security status of the Airport change at any time during the term of this Contract, a written notice shall be issued to the Contractor detailing all applicable security modifications from the airport's current security status. The Contractor shall take **immediate steps** to comply with those security modifications as directed in the written notice.

If these security modifications involve any additional project cost, the Contractor shall submit a Contractor Change Request in accordance with the General Conditions for the additional cost. The Contractor Change Request shall outline in specific detail the effects of the security modifications on the Contractor's performance of the Contract, and shall provide a detailed cost breakdown for each item for which the Contractor is requesting reimbursement.

The Contractor shall return to the City, at contract completion or termination, or upon demand by the City, all access keys issued to it by the City to all areas of the Airport. If the Contractor fails to return any such key or keys at contract completion or termination or upon demand by the City, the Contractor shall be liable to the City for all the City's costs, including the City's labor costs for employees, incurred in re-coring doors and any other work which is required to prevent compromise of the Airport security system. In order to collect such costs hereunder, the City may withhold funds in such amount from any amounts due and payable to the Contractor under this Contract.

The construction of all the Project / Task Items that involve the breaching of any airport perimeter security boundary or continued access to restricted access rooms or areas will require the posting of authorized contract security personnel to maintain required security controls. The Contractor's **Total Contract BID Amount** shall include the cost of providing security services to maintain control and supervision of any and all airport perimeter security boundary breaches and for the duration of work activities where access to restricted areas is required and until the airport perimeter security boundaries are reestablished.

When security boundaries are opened for any reason, the Contractor must maintain one hundred percent (100%) control and supervision for the entire time that the openings are present to prevent unauthorized access to the secure / restricted access areas.

**THE IMPORTANCE OF THIS SPECIAL CONDITION CANNOT BE OVER-EMPHASIZED. SEVERE FINANCIAL PENALTIES AS WELL AS CONTRACT TERMINATION COULD RESULT IF AIRPORT PERIMETER SECURITY REQUIREMENTS ARE NOT STRICTLY FOLLOWED. THE REQUIREMENT TO PROVIDE ONE HUNDRED PERCENT (100%) CONTROL AND SUPERVISION OF BREACHES IN THE AIRPORT'S PERIMETER SECURITY BOUNDARY IS ABSOLUTE. AT NO TIME, DURING WORK AND NON-WORK HOURS SHALL ANY BREACHES IN THE AIRPORT'S SECURITY PERIMETER BE UNSUPERVISED AND / OR UNSECURED.**

For off-hours of construction, the Contractor may choose to erect a temporary wall to close all perimeter openings. The wall construction shall be of sufficient materials and strength to prevent access to the airport's Sterile/Restricted Areas. The Contractor shall submit for review and approval, the details and materials for the temporary closure of security perimeter breaches for review and approval.

The Contractor will provide contract security guard services to maintain supervision of these openings. The security services must provide coverage to allow for lunch breaks, comfort breaks, etc. The security services **must** be obtained from the following contract security guard company:

Covenant Aviation Security, LLC  
1112 W. Boughton Road  
Suite 355  
Bolingbrook, IL 60440

DEN Contact:  
Covenant Management  
720-222-4774

All security guards provided for this project must have a Denver Airport SIDA Badge.

The DEN Security Guard Contractor may change between the bidding or Bid phase of this contract from Notice to Proceed to closure of all security perimeter breaches. The Contractor shall maintain a contractual relationship with the Security Guard Contractor holding the most current contract with Denver International Airport.

The Contractor shall continue to provide security of these areas until such time that the breaches in the airport's security perimeter have been permanently secured.

The Contractor shall submit a written security plan for approval to the Director of Airport Security prior to the start of construction on any work where a breach of the perimeter security boundaries is required.

#### **SC-10 CONSTRUCTION ACCESS**

The work site(s) is/are located at Denver International Airport, Northeast side of Concourse C. The Contractor shall have access to the work site via Gate P-27. The Contractor is responsible for ensuring that all of the Contractor's and Subcontractor's personnel have the ability to access and locate the areas of work where the scope is to be performed without additional escorting or supervision from DEN.

The City will not provide parking spaces for the Contractor's employees or subcontractor employees at the Airport. Arrangements for transportation and parking for all of its and its subcontractors' employees will be the responsibility of the Contractor. The Total Contract Bid Amount or Contract Amount shall include any and all costs associated with the Contractor's and subcontractors' employee parking. Information about parking facilities and charges is available from the Airport Parking Office. Refundable deposits are required for all parking passes.

Unless specifically required by the Contract Documents, the Contractor shall install no fences or other physical obstructions on or around any project work area without the approval of the City.

#### **SC-11 VEHICLE PERMITTING**

Vehicle access on the Airport Operation Area ("AOA") is controlled by and requires permission from the Airport Access Services Office. It is not anticipated that the Contractor will need to operate vehicles on the AOA to perform the Work. Only direct construction support vehicles and/or equipment will be allowed in the contractor's work areas or sites.

#### **SC-12 VENDORS AND SUPPLIERS**

The Contractor shall provide the Project Manager's office with a list of its equipment/material vendors and suppliers. Vendors or suppliers shall access the construction work areas via the Contractor's access route, described in SC-10 above. All delivery vehicles are subject to search.

#### **SC-13 COMMUNICATION DEVICES**

Any site communications devices, mobile communication devices or internet data devices used at DEN must be approved by DEN Technologies.

#### **SC-14 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS**

The Contractor and its officers, agents, and employees shall cooperate and comply with the provisions of Executive Order No. 94 and Attachment A thereto concerning the use, possession, or sale of alcohol or drugs. Violation of these provisions or refusal to cooperate with implementation of the policy can result in the City's barring the Contractor from City facilities or participating in City operations.

#### **SC-15 ATTORNEYS' FEES**

Colorado Revised Statute 38-26-107 requires that in the event any person or company files a verified statement of amounts due and unpaid in connection with a claim for labor and materials supplied on this project, the City shall withhold from payments to the Contractor sufficient funds to insure the payment of any such claims. Should the City and County of Denver be made a party to any lawsuit to enforce such unpaid claims or any lawsuit arising out of or relating to such withheld funds, Contractor agrees to pay to the City its costs and a reasonable attorney's fee. Because the City Attorney Staff does not bill the City for legal services on an hourly basis, Contractor agrees a reasonable fee shall be computed at the rate of two hundred dollars per hour of City Attorney time.

#### **SC-16 INSURANCE REQUIREMENTS**

In accordance with the provisions of Title 16 of the General Conditions, the minimum insurance requirements for this contract are set forth in Section II-15 of the Instructions to Bidders. The Contractor specifically agrees to comply with each condition, requirement or specification set forth in the attachment for each required coverage during all periods when the required coverages are in effect.

Contractor and sub-contractors shall procure and maintain until all of their obligations have been discharged, including any warranty periods under this Contract are satisfied, required insurance against claims for injury to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Contractor, his agents, representatives, employees or sub-contractors.

The insurance requirements herein are minimum requirements for this Contract and in no way limit the indemnity covenants contained in this Contract.

The City and County of Denver in no way warrants that the minimum limits contained herein are sufficient to

protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, his agents, representatives, employees or sub-contractors. The Contractor shall assess its own risks as it deems appropriate and/or prudent, maintain higher limits and/or broader coverages. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration or types.

Contractor shall furnish the City and County of Denver with certificates of insurance (ACORD form or equivalent approved by CCD) as required by this Contract. The certificates for each insurance policy are to be signed by a person authorized by the insurer to bind coverage on its behalf.

All certificates and any required endorsements are to be received and approved by the City before work commences. Each insurance policy required by this Contract must be in effect at or prior to commencement of work under this Contract and remain in effect for the duration of the project. Failure to maintain the insurance policies as required by this Contract or to provide evidence of renewal is a material breach of the Contract. All insurance coverages for sub-contractors shall be subject to the minimum requirements identified in the Exhibit. All sub-contractors' certificates and endorsements shall be received and approved by the Contractor before work commences. The City reserves the right to request copies of these certificates at any time.

All certificates required by this Contract shall be sent directly to [ContractAdminInvoices@flydenver.com](mailto:ContractAdminInvoices@flydenver.com). The City project/contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time.

The parties hereto understand and agree that the City and County of Denver, its officers, officials and employees, are relying on, and do not waive or intend to waive by any provisions of this Contract, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, §§ 24-10-101 - 120, C.R.S., or otherwise available to the City and County of Denver, its officers, officials and employees.

#### **SC-17 SUBCONTRACTOR RELEASES**

The release form referred to in General Condition 907 is attached to this Contract. It is entitled "Denver International Airport Partial Release."

#### **SC-18 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS**

This contract is subject and subordinate to the terms, reservations, restrictions, and conditions of any existing or future agreements between the City and the United States, the execution of which has been or may be required as a condition precedent to the transfer of federal rights or property to the City for airport purposes, and the expenditure of federal funds for airport purposes. The "Federal Requirements" section attached hereto is made a part of this Contract.

#### **SC-19 ESTIMATED QUANTITIES OF UNIT PRICED ITEMS**

The "total estimated quantity" of each unit price item as stated on the bid schedules shall be the estimated quantity which is used to determine the percentage of change in such item for purposes of G.C. 1104.7.

#### **SC-20 REVISIONS TO G.C. 1102**

G.C. 1102.2 is amended by replacing the phrase "Change Request" in all its occurrences in such G.C. with the phrase "Change Notice."

G.C. 1102.3 is amended by replacing the phrase "Field Order/Change Order Directive" in all its occurrences in such G.C. with the phrase "Change Order Directive."

**SC-21 LISTING OF ACCEPTABLE MANUFACTURERS**

The Technical Specifications list "Acceptable Manufacturers" for certain products. Such listing identifies manufacturers of certain products which have been determined by a preliminary review to be able to meet the basic product and/or system technical requirements. The listing is not intended to provide a blanket endorsement or acceptance of the manufacturer's specified products or product line. All products from listed manufacturers must meet the detailed requirements of the Technical Specifications. Products that do not meet all detailed Technical Specifications are not acceptable and will be rejected, regardless of whether the manufacturer was listed as "acceptable." The Contractor is responsible for determining the acceptability of all products under the Technical Specifications prior to submission of products for approval.

**SC-22 ACCESSIBLE PARKING SPACES, ACCESS AISLES AND ROUTES OF TRAVEL**

If any Work is performed in or adjacent to parking facilities at the Airport, the Contractor is responsible for compliance with this SC-30. "Accessible" parking spaces and access aisles as used in this SC-30 mean parking spaces and access aisles which are accessible for, and reserved for use by, persons with disabilities. These parking spaces and access aisles are designed and built to standards established by federal regulations implementing the Americans with Disabilities Act of 1990 ("ADA") and are marked by signage. "Accessible routes of travel" as used herein means routes through parking facilities which comply with ADA accessibility standards, including degree of slope and absence of obstructions.

Accessible routes of travel and accessible parking spaces and access aisles must be kept free of obstructions and construction debris at all times. No accessible parking spaces or access aisles or accessible routes of travel shall be relocated, blocked or rendered unusable unless the contractor has obtained specific advance approval in writing for such actions from the airport's ADA Compliance Officer.

When prosecution of the Work requires that accessible spaces be temporarily blocked, those accessible spaces and their access aisles shall be temporarily relocated to another location as close as possible to an accessible building entrance. Temporary signage that identifies these parking spaces and access aisles as reserved for the handicapped shall be installed, and the accessible route shall be clearly marked as required.

Before blocking or relocating accessible parking spaces or accessible routes of travel, the contractor must obtain written approval from the DEN ADA Compliance Officer, by submitting a completed request form, which will be provided to the Contractor by the Project Manager at the preconstruction meeting if it is not included as a standard form in Section 019990 of the Technical Specifications. The request shall include the location of alternative spaces and/or routes, and specifications of the temporary signage to be used. Work shall not proceed without this approval.

If a vehicle is parked in any accessible space which is either temporary or approved to be relocated, the contractor will not remove signage or take any other action which would allow the access aisle for such parking space to be blocked. Such actions must be postponed until the parking space is no longer occupied.

**SC-23 SUBCONTRACTOR PAYMENTS AND SUBCONTRACTOR RELEASES – REQUIRED USE OF THE B2G CONTRACT MANAGEMENT SYSTEM**

The Contractor is required to use the City B2G Contract Management System to report all subcontractor payments and shall adhere to the City's Procedure for Reporting Subcontractor Payments. It is the Contractor's obligation to ensure that complete subcontractor information is entered into the B2G System prior to submission of the first application for payment in order to avoid any delays in payment. The Contractor shall, prior to the submission of each subsequent invoice, ensure payments to subcontractors have been entered into the B2G System, including subcontractor confirmation of amount of payment received, for services performed during the prior billing period.

**SC-24 PAYMENTS TO CONTRACTORS**

The Contractor recognizes and agrees that applications for payment shall be submitted using the Textura® Payment Management System (PPM System), which will also be the payment mechanism to disburse payments to sub-contractors used on this Project. For more information, please refer to Division I, Technical Specifications.

The Contractor further agrees that, to the fullest possible within the TPM System, the City shall be entitled to all non-Confidential records, reports, data and other information related to the project that are available to Contractor through the TPM System, including, but not limited to, information related to Contractor and subcontractor billings. To that end, Contractor agrees that it will activate any available settings within the TPM System that are necessary to grant the City access to such non-Confidential information related to the contract and the project. Applications for payment shall be based on the Contract Unit Prices or the approved Schedule of Values described in GC 903.1

In accordance with General Contract Condition 902, PAYMENT PROCEDURE, the party(ies) responsible for review of all Pay Applications shall be:

**Agency/Firm**

DEN Division CA  
DEN Division PM  
DEN Division Director  
DEN Contract Procurement CA  
CCD Denver Prevailing Wage

In accordance with General Contract Condition 906, APPLICATIONS FOR PAYMENT, each Application submitted shall include the following:

1. The estimate of Work completed shall be based on the approved schedule of values or unit prices, as applicable, and the percent of the Work complete.
2. Each Application for Payment shall include each and every independent subcontractor's payroll information including pay dates and pay amounts.
3. The Contractor shall also submit to the Auditor and other appropriate officials of the City in a timely fashion, information required by General Contract Condition 1004, REPORTING WAGES PAID.

In accordance with General Contract condition 907, RELEASES AND CONTRACTORS' CERTIFICATION OF PAYMENT, Applications for Payment must be accompanied by a completed Partial or Final Claim Release Form, as appropriate, from EACH subcontractor and supplier, **AND** the Contractor's Certification of Payment Form.

**SC-25 CONFIRMATION OF LAWFUL EMPLOYMENT**

General Condition 311 is deleted in its entirety and replaced by:

**311 No employment of a worker without authorization to perform work under the agreement.**

1. This Agreement is subject to Division 5 of Article IV of Chapter 20 of the Denver Revised Municipal Code, and any amendments (the "Certification Ordinance").
2. The Contractor certifies that:

- A. At the time of its execution of this Agreement, it does not knowingly employ or contract with a worker without authorization who will perform work under this Agreement, nor will it knowingly employ or contract with a worker without authorization to perform work under this Agreement in the future.
  - B. It will participate in the E-Verify Program, as defined in § 8-17.5-101(3.7), C.R.S., and confirm the employment eligibility of all employees who are newly hired for employment to perform work under this Agreement.
  - C. It will not enter into a contract with a subconsultant or subcontractor that fails to certify to the Contractor that it shall not knowingly employ or contract with a worker without authorization to perform work under this Agreement.
  - D. It is prohibited from using the E-Verify Program procedures to undertake pre-employment screening of job applicants while performing its obligations under this Agreement, and it is required to comply with any and all federal requirements related to use of the E-Verify Program including, by way of example, all program requirements related to employee notification and preservation of employee rights.
  - E. If it obtains actual knowledge that a subconsultant or subcontractor performing work under this Agreement knowingly employs or contracts with a worker without authorization, it will notify such subconsultant or subcontractor and the City within three (3) days. The Contractor shall also terminate such subconsultant or subcontractor if within three (3) days after such notice the subconsultant or subcontractor does not stop employing or contracting with the worker without authorization, unless during the three-day period the subconsultant or subcontractor provides information to establish that the subconsultant or subcontractor has not knowingly employed or contracted with a worker without authorization.
  - F. It will comply with a reasonable request made in the course of an investigation by the Colorado Department of Labor and Employment under authority of § 8-17.5-102(5), C.R.S., or the City Auditor, under authority of D.R.M.C. 20-90.3.
3. The Contractor is liable for any violations as provided in the Certification Ordinance. If the Contractor violates any provision of this section or the Certification Ordinance, the City may terminate this Agreement for a breach of the Agreement. If this Agreement is so terminated, the Contractor shall be liable for actual and consequential damages to the City. Any termination of a contract due to a violation of this section or the Certification Ordinance may also, at the discretion of the City, constitute grounds for disqualifying the Contractor from submitting bids or proposals for future contracts with the City.

**EXHIBIT F**

**City and County of Denver**



**D E N V E R**  
**THE MILE HIGH CITY**

**DEPARTMENT OF AVIATION  
DEPARTMENT OF PUBLIC WORKS**

**STANDARD SPECIFICATIONS FOR  
CONSTRUCTION  
GENERAL CONTRACT CONDITIONS**

**2011 Edition**

**Statement**

The City and County of Denver does not warrant or represent the accuracy or timeliness of the information contained in this page or any of its constituent pages and the information presented is for instructional purposes and illustration only and is not intended to be specific advice, legal or otherwise. The City has made every effort to provide accurate up-to-date information, however this database is dynamic and errors can occur. The City and County of Denver shall not be held responsible for errors or omissions nor be liable for any special consequential or exemplary damages resulting, in whole or in part, from any viewer(s)' uses of, or in reliance upon, this material.

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Liberty Bond No. 015219985  
Travelers Bond No. 107766496  
F&D/Zurich Bond No. 9416629  
Federal Bond No. K41614225  
Continental Bond No. 30172839  
Berkshire Bond No. 47-SUR-300033-01-0702

**PERFORMANCE BOND**

**KNOW ALL MEN BY THESE PRESENTS**, that we, the undersigned Flatiron Constructors, Inc., a corporation organized under the laws of the State of Delaware, hereinafter referred to as the "Contractor" and SEE ATTACHMENT A, a corporation organized under the laws of the State of SEE ATTACHMENT A, and authorized to transact business in the State of Colorado, hereinafter referred to as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", in the penal sum of **Sixty Million, Four Hundred Sixty-One Thousand, Seven Hundred Seventy and 05/100 Dollars** (\$ 60,461,770.05 ), lawful money of the United States of America, for the payment of which sum the Contractor and Surety bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally by these presents.

**WHEREAS**, the above Contractor has, as of the date of execution listed on the contract signature page, entered into a written contract with the City for furnishing all labor, materials, equipment, tools, superintendence, and other facilities and accessories for the construction of Contract No. IFB No. 202366450, Taxiway DS East and Deicing Pad, at Denver International Airport, in accordance with the Technical Specifications, Contract Drawings and all other Contract Documents therefor which are incorporated herein by reference and made a part hereof, and are herein referred to as the Contract.

**NOW, THEREFORE**, the condition of this performance bond is such that if the Contractor:

1. Promptly and faithfully observes, abides by and performs each and every covenant, condition and part of said Contract, including, but not limited to, its warranty provisions, in the time and manner prescribed in the Contract, and
2. Pays the City all losses, damages (liquidated or actual, including, but not limited to, damages caused by delays in the performance of the Contract), expenses, costs and attorneys' fees, that the City sustains resulting from any breach or default by the Contractor under the Contract, then this bond is void; otherwise, it shall remain in full force and effect.

**IN ADDITION**, if said Contractor fails to duly pay for any labor, materials, team hire, sustenance, provisions, provender, or any other supplies used or consumed by said Contractor or its subcontractors in its performance of the work contracted to be done or fails to pay any person who supplies rental machinery, tools, or equipment, all amounts due as the result of the use of such machinery, tools, or equipment in the prosecution of the work, the Surety shall pay the same in an amount not exceeding the amount of this obligation, together with interest as provided by law.

**PROVIDED FURTHER**, that the said Surety, for value received, hereby stipulates and agrees that any and all changes in the Contract or compliance or noncompliance with the formalities in the Contract for making such changes shall not affect the Surety's obligations under this bond and the Surety hereby waives notice of any such changes.

(End of Page)

IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 13th day of March, 2023.

By:   
Kevin McCormick  
DIVISION FINANCE MANAGER



Flatiron Constructors, Inc.  
CONTRACTOR

By:   
President GRANT JOHNS  
VICE PRESIDENT

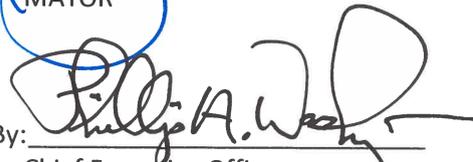
SEE ATTACHMENT A  
SURETY

By: SEE ATTACHMENT A  
Attorney-in-Fact

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond.)

CITY AND COUNTY OF DENVER

By:   
MAYOR

By:   
Chief Executive Officer  
Denver International Airport

APPROVED AS TO FORM:

KERRY TIPPER, Attorney for the City  
and County of Denver

By:   
Assistant City Attorney

## ATTACHMENT A

Liberty Mutual Insurance Company, a Massachusetts Corporation  
Travelers Casualty and Surety Company of America, a Connecticut corporation  
Fidelity and Deposit Company of Maryland, an Illinois corporation  
Zurich American Insurance Company, a New York corporation  
Federal Insurance Company, an Indiana corporation  
The Continental Insurance Company, a Pennsylvania Corporation  
Berkshire Specialty Insurance Company, a Nebraska Corporation

**Liberty Mutual Insurance Company – A.M. Best Rating A XV; NAIC# 23043**

175 Berkeley Street, Boston, MA 02116; Tel.: (212) 719-7750; Fax (212) 221-5608

Contact: David D. Roberts, Branch Manager, [davidd.roberts@libertymutual.com](mailto:davidd.roberts@libertymutual.com)

**Mailing Address for Claims Notices:**

Sam E. Barker, Director-AsiaPac, Global Risk Claims

[Sam.barker@libertymutual.com](mailto:Sam.barker@libertymutual.com) or [HOSCL@Libertymutual.com](mailto:HOSCL@Libertymutual.com)

Safeco Plaza, 1001 4<sup>th</sup> Avenue, Suite 3800

Seattle, WA 98154

**Bond No. 015219985**

**Travelers Casualty and Surety Company of America – A.M. Best Rating A++ XV; NAIC# 31194**

Construction Services, One Tower Square, Hartford, CT 06183; Tel.: (860) 277-1914; Fax (860) 277-3931

Contact: Jacob Fulmer, Regional Underwriting Officer, [jfulmer1@travelers.com](mailto:jfulmer1@travelers.com)

**Bond No. 107766496**

**Fidelity and Deposit Company of Maryland - A.M. Best Rating A+ XV; NAIC# 39306**

**Zurich American Insurance Company - A.M. Best Rating A+ XV; NAIC# 16535**

1299 Zurich Way, 5<sup>th</sup> Floor, Schaumburg, IL 60196; Tel.: (410) 559-8739; Fax (410) 261-7957

Contact: Douglas Sauer, Underwriting Officer, [douglas.sauer@zurichna.com](mailto:douglas.sauer@zurichna.com)

**Bond No. 9416629**

**Federal Insurance Company – A.M. Best Rating A++ XV; NAIC# 20281**

202B Hall's Mill Road, Whitehouse Station, NJ 08889; Tel.: (908) 903-4868; Fax (908) 903-3656

Contact: Brock Masterson, Senior VP/Director Construction Surety, [brock.masterson@chubb.com](mailto:brock.masterson@chubb.com)

**Bond No. K41614225**

**The Continental Insurance Company – A.M. Best Rating A XV; NAIC# 35289**

151 N Franklin Street, Chicago, IL 60606; Tel.: (212) 440-7356; Fax (212) 440-7351

Contact: Jon Fullerton, Branch Manager, [jon.fullerton@cnsurety.com](mailto:jon.fullerton@cnsurety.com)

**Bond No. 30172839**

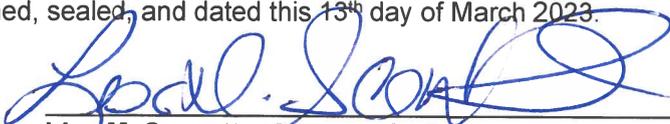
**Berkshire Specialty Insurance Company – A.M. Best Rating A++ XV; NAIC# 22276**

1314 Douglas Street, Suite 1400, Omaha, NE 68102; Tel.: (617) 936-2971; Fax (N/A)

Contact: Courtney T. Walker, Senior Vice President Surety, [courtney.walker@bhspecialty.com](mailto:courtney.walker@bhspecialty.com)

**Bond No. 47-SUR-300033-01-0702**

Signed, sealed, and dated this 13<sup>th</sup> day of March 2023.

By: 

**Lisa M. Scavetta, Attorney-In-Fact**

Turner Surety and Insurance Brokerage, Inc.

250 Pehle Avenue, Suite 311, Saddle Brook, NJ 07663

Office: 201-267-7507 | Fax: 201-267-7532

Email: [lscavetta@tsibinc.com](mailto:lscavetta@tsibinc.com) | CA License # 0E81386

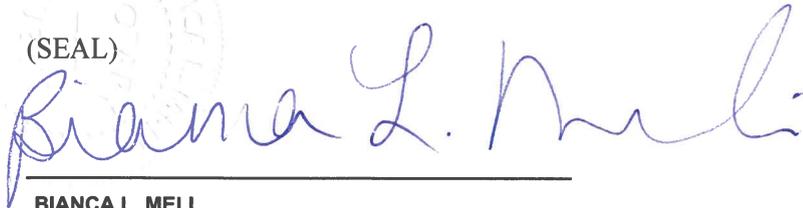
**CORPORATE ACKNOWLEDGMENT**

Form 152

STATE OF NEW JERSEY  
COUNTY OF BERGEN

On this 13<sup>th</sup> day of March, 2023 before me personally came Lisa M. Scavetta to me known, who, being by me duly sworn, did depose and say that she/he resides in Bronxville, New York that she/he is the ATTORNEY IN FACT of the LIBERTY MUTUAL INSURANCE COMPANY, TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, FIDELITY AND DEPOSIT COMPANY OF MARYLAND, ZURICH AMERICAN INSURANCE COMPANY, FEDERAL INSURANCE COMPANY, THE CONTINENTAL INSURANCE COMPANY, BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, the corporation described in and which executed the above instrument that she/he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that she/he signed her/his name thereto by like order.

(SEAL)



BIANCA L. MELI

NOTARY PUBLIC, STATE OF NEW JERSEY  
MY COMMISSION EXPIRES

SEPTEMBER 30, 2024



LIBERTY MUTUAL INSURANCE COMPANY  
FINANCIAL STATEMENT — DECEMBER 31, 2021

Assets		Liabilities	
Cash and Bank Deposits .....	\$2,234,770,744	Unearned Premiums .....	\$9,106,965,847
*Bonds — U.S Government .....	4,250,615,811	Reserve for Claims and Claims Expense .....	25,279,158,493
*Other Bonds .....	16,983,165,862	Funds Held Under Reinsurance Treaties .....	315,537,902
*Stocks .....	20,075,458,019	Reserve for Dividends to Policyholders .....	1,726,291
Real Estate .....	182,250,567	Additional Statutory Reserve .....	139,634,000
Agents' Balances or Uncollected Premiums .....	7,607,687,836	Reserve for Commissions, Taxes and Other Liabilities .....	8,638,106,801
Accrued Interest and Rents .....	120,173,987	<b>Total .....</b>	<b>\$43,481,129,334</b>
Other Admitted Assets .....	14,076,622,575	Special Surplus Funds .....	\$178,192,363
		Capital Stock .....	10,000,075
		Paid in Surplus .....	11,804,736,755
		Unassigned Surplus .....	10,056,686,874
<b>Total Admitted Assets .....</b>	<b><u>\$65,530,745,401</u></b>	<b>Surplus to Policyholders .....</b>	<b>22,049,616,067</b>
		<b>Total Liabilities and Surplus .....</b>	<b><u>\$65,530,745,401</u></b>



\* Bonds are stated at amortized or investment value; Stocks at Association Market Values.  
The foregoing financial information is taken from Liberty Mutual Insurance Company's financial statement filed with the state of Massachusetts Department of Insurance.

I, TIM MIKOLAJEWSKI, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the foregoing is a true, and correct statement of the Assets and Liabilities of said Corporation, as of December 31, 2021, to the best of my knowledge and belief.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Corporation at Seattle, Washington, this 8<sup>th</sup> day of March, 2022.

*T. Mikolajewski*

Assistant Secretary



This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

Certificate No: 8208613-974450

POWER OF ATTORNEY

KNOWN ALL PERSONS BY THESE PRESENTS: That The Ohio Casualty Insurance Company is a corporation duly organized under the laws of the State of New Hampshire, that Liberty Mutual Insurance Company is a corporation duly organized under the laws of the State of Massachusetts, and West American Insurance Company is a corporation duly organized under the laws of the State of Indiana (herein collectively called the "Companies"), pursuant to and by authority herein set forth, does hereby name, constitute and appoint, Bianca L. Meli; Charo J. Rosemond; James Baldassare, Jr.; John F. Surano; Krista A. Burke; Lisa M. Scavetta; Maria L. Spadaccini; Michael Dugan; Nicholas F. Walsh; Sherryanne M. DePirro

all of the city of Saddle Brook state of NJ each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents and shall be as binding upon the Companies as if they have been duly signed by the president and attested by the secretary of the Companies in their own proper persons.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Companies and the corporate seals of the Companies have been affixed thereto this 18th day of August, 2022.



Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

By: David M. Carey

David M. Carey, Assistant Secretary

State of PENNSYLVANIA
County of MONTGOMERY ss

On this 18th day of August, 2022 before me personally appeared David M. Carey, who acknowledged himself to be the Assistant Secretary of Liberty Mutual Insurance Company, The Ohio Casualty Company, and West American Insurance Company, and that he, as such, being authorized so to do, execute the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.



Commonwealth of Pennsylvania - Notary Seal
Teresa Pastella, Notary Public
Montgomery County
My commission expires March 28, 2025
Commission number 1126044
Member, Pennsylvania Association of Notaries

By: Teresa Pastella
Teresa Pastella, Notary Public

This Power of Attorney is made and executed pursuant to and by authority of the following By-laws and Authorizations of The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company which resolutions are now in full force and effect reading as follows:

ARTICLE IV - OFFICERS: Section 12. Power of Attorney.

Any officer or other official of the Corporation authorized for that purpose in writing by the Chairman or the President, and subject to such limitation as the Chairman or the President may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Corporation to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Corporation by their signature and execution of any such instruments and to attach thereto the seal of the Corporation. When so executed, such instruments shall be as binding as if signed by the President and attested to by the Secretary. Any power or authority granted to any representative or attorney-in-fact under the provisions of this article may be revoked at any time by the Board, the Chairman, the President or by the officer or officers granting such power or authority.

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.

Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

Certificate of Designation - The President of the Company, acting pursuant to the Bylaws of the Company, authorizes David M. Carey, Assistant Secretary to appoint such attorneys-in-fact as may be necessary to act on behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

Authorization - By unanimous consent of the Company's Board of Directors, the Company consents that facsimile or mechanically reproduced signature of any assistant secretary of the Company, wherever appearing upon a certified copy of any power of attorney issued by the Company in connection with surety bonds, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

I, Renee C. Llewellyn, the undersigned, Assistant Secretary, The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy of the Power of Attorney executed by said Companies, is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 13th day of March, 2023.



By: Renee C. Llewellyn

Renee C. Llewellyn, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, currency rate, interest rate or residual value guarantees.

For bond and/or Power of Attorney (POA) verification inquiries, call 1-800-368-3683.

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA

HARTFORD, CONNECTICUT 06183

FINANCIAL STATEMENT AS OF DECEMBER 31, 2021

CAPITAL STOCK \$ 6,480,000

ASSETS		LIABILITIES & SURPLUS	
BONDS	\$ 4,427,068,873	LOSSES	\$ 1,224,258,147
STOCKS	90,892,083	LOSS ADJUSTMENT EXPENSES	157,266,812
CASH AND INVESTED CASH	3,976,380	COMMISSIONS	49,877,644
OTHER INVESTED ASSETS	4,609,133	OTHER EXPENSES	46,607,590
SECURITIES LENDING REINVESTED COLLATERAL ASSETS	7,433,086	TAXES, LICENSES AND FEES	16,655,025
INVESTMENT INCOME DUE AND ACCRUED	37,877,324	CURRENT FEDERAL AND FOREIGN INCOME TAXES	1,972,277
PREMIUM BALANCES	294,081,729	UNEARNED PREMIUMS	1,212,347,629
REINSURANCE RECOVERABLE	70,677,646	ADVANCE PREMIUM	1,824,313
NET DEFERRED TAX ASSET	60,156,960	POLICYHOLDER DIVIDENDS	14,256,052
OTHER ASSETS	3,286,703	CEDED REINSURANCE NET PREMIUMS PAYABLE	47,473,619
		AMOUNTS WITHHELD / RETAINED BY COMPANY FOR OTHERS	42,097,038
		REMITTANCES AND ITEMS NOT ALLOCATED	10,579,448
		PROVISION FOR REINSURANCE	6,873,132
		PAYABLE TO PARENT, SUBSIDIARIES AND AFFILIATES	40,373,235
		PAYABLE FOR SECURITIES LENDING	7,433,086
		ESCHEAT LIABILITY	537,132
		RETROACTIVE REINSURANCE RESERVE ASSUMED	816,092
		OTHER ACCRUED EXPENSES AND LIABILITIES	250,005
		TOTAL LIABILITIES	\$ 2,881,598,277
		CAPITAL STOCK	\$ 6,480,000
		PAID IN SURPLUS	433,803,760
		OTHER SURPLUS	1,678,177,878
		TOTAL SURPLUS TO POLICYHOLDERS	\$ 2,118,461,638
TOTAL ASSETS	\$ 5,000,059,915	TOTAL LIABILITIES & SURPLUS	\$ 5,000,059,915

STATE OF CONNECTICUT )  
 COUNTY OF HARTFORD ) SS.  
 CITY OF HARTFORD )

MICHAEL J. DOODY, BEING DULY SWORN, SAYS THAT HE IS VICE PRESIDENT - FINANCE, OF TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, AND THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT STATEMENT OF THE FINANCIAL CONDITION OF SAID COMPANY AS OF THE 31ST DAY OF DECEMBER, 2021.

*Michael J. Doody*  
 VICE PRESIDENT - FINANCE

SUBSCRIBED AND SWORN TO BEFORE ME THIS  
 17TH DAY OF MARCH, 2022

*Susan M. Weissleder*  
 NOTARY PUBLIC



SUSAN M. WEISSLEDER  
 Notary Public  
 My Commission Expires November 30, 2022



**Travelers Casualty and Surety Company of America  
Travelers Casualty and Surety Company  
St. Paul Fire and Marine Insurance Company**

**POWER OF ATTORNEY**

**KNOW ALL MEN BY THESE PRESENTS:** That Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company are corporations duly organized under the laws of the State of Connecticut (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint **Lisa M. Scavetta** of **SADDLE BROOK**, their true and lawful Attorney(s)-in-Fact to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

**IN WITNESS WHEREOF**, the Companies have caused this instrument to be signed, and their corporate seals to be hereto affixed, this **21st** day of **April**, 2021.



State of Connecticut

City of Hartford ss.

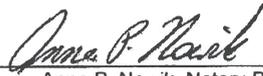
By:   
Robert L. Raney, Senior Vice President

On this the **21st** day of **April**, 2021, before me personally appeared **Robert L. Raney**, who acknowledged himself to be the Senior Vice President of each of the Companies, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of said Companies by himself as a duly authorized officer.

**IN WITNESS WHEREOF**, I hereunto set my hand and official seal.

My Commission expires the **30th** day of **June**, 2026



  
Anna P. Nowik, Notary Public

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of each of the Companies, which resolutions are now in full force and effect, reading as follows:

**RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

**FURTHER RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

**FURTHER RESOLVED**, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

**FURTHER RESOLVED**, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, **Kevin E. Hughes**, the undersigned, Assistant Secretary of each of the Companies, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which remains in full force and effect.

Dated this **13th** day of **March**, 2023.



  
Kevin E. Hughes, Assistant Secretary

**To verify the authenticity of this Power of Attorney, please call us at 1-800-421-3880.  
Please refer to the above-named Attorney(s)-in-Fact and the details of the bond to which this Power of Attorney is attached.**

**THE FIDELITY AND DEPOSIT COMPANY**

OF MARYLAND  
1299 Zurich Way Schaumburg, IL 60196

**Statement of Financial Condition**  
As Of December 31, 2021

**ASSETS**

Bonds.....	\$ 237,467,504
Stocks .....	18,985,762
Cash and Short-Term Investments .....	7,415,852
Reinsurance Recoverable .....	25,735,324
Federal Income Tax Recoverable.....	0
Other Accounts Receivable.....	24,479,233
<b>TOTAL ADMITTED ASSETS.....</b>	<b>\$ 314,083,675</b>

**LIABILITIES, SURPLUS AND OTHER FUNDS**

Reserve for Taxes and Expenses .....	\$ 378,101
Ceded Reinsurance Premiums Payable .....	48,876,599
Remittances and Items Unallocated .....	0
Payable to parents, subs and affiliates .....	0
Securities Lending Collateral Liability.....	0
<b>TOTAL LIABILITIES .....</b>	<b>\$ 49,254,700</b>
Capital Stock, Paid Up .....	\$ 5,000,000
Surplus.....	264,828,975
Surplus as regards Policyholders.....	264,828,975
<b>TOTAL .....</b>	<b>\$ 314,083,675</b>

Securities carried at \$78,561,855 in the above statement are deposited with various states as required by law.

Securities carried on the basis prescribed by the National Association of Insurance Commissioners. On the basis of market quotations for all bonds and stocks owned, the Company's total admitted assets at December 31, 2021 would be \$319,561,762 and surplus as regards policyholders \$270,307,062.

I, LAURA J. LAZARCZYK, Corporate Secretary of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company on the 31st day of December, 2021.

DocuSigned by:  
*Laura J. Lazarczyk*  
42DF60B471374B0...  
Corporate Secretary

State of Illinois }  
City of Schaumburg } SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15<sup>th</sup> day of March, 2022.



*Ryan Horgan*  
Notary Public

**ZURICH AMERICAN INSURANCE COMPANY**  
**COMPARATIVE BALANCE SHEET**  
**4 WORLD TRADE CENTER, 150 GREENWICH STREET, NEW YORK, NY 10007**  
**As of December 31, 2021 and December 31, 2020**

<u>Assets</u>	12/31/2021	12/31/2020
Bonds	\$ 16,632,198,754	\$ 15,696,060,158
Preferred Stock	-	-
Common Stock	2,938,741,320	2,964,630,407
Real Estate	1,195,108,770	1,294,160,876
Other Invested Assets	1,511,224,849	1,435,120,966
Derivatives	4,892,042	178,175
Short-term Investments	562,958	285,002
Receivable for securities	22,712,596	809,339
Cash and cash equivalents	157,712,608	526,475,686
Securities lending reinvested collateral assets	-	105,614,095
Employee Trust for Deferred Compensation Plan	114,975,842	122,225,149
Total Cash and Invested Assets	\$ 22,578,129,739	\$ 22,145,559,853
Premiums Receivable	\$ 5,896,173,688	\$ 5,318,928,254
Funds Held with Reinsurers	-	99,875
Reinsurance Recoverable	1,288,549,705	1,248,855,148
Accrued Investment Income	118,060,365	118,531,136
Federal Income Tax Recoverable	471,599,585	507,200,404
Due from Affiliates	129,012,120	92,277,523
Other Assets	538,603,889	559,476,243
Total Assets	\$ 31,020,129,090	\$ 29,990,928,434
<b><u>Liabilities and Policyholders' Surplus</u></b>		
<b>Liabilities:</b>		
Loss and LAE Reserves	\$ 12,244,569,908	\$ 12,295,705,961
Unearned Premium Reserve	4,276,836,095	3,952,940,831
Funds Held with Reinsurers	674,404,810	554,226,440
Loss In Course of Payment	1,673,061,383	1,351,312,377
Commission Reserve	160,324,275	119,930,116
Federal Income Tax Payable	10,641,098	34,772,832
Remittances and Items Unallocated	336,655,509	432,727,110
Payable to parent, subs and affiliates	353,084,887	273,601,687
Provision for Reinsurance	89,554,951	175,327,995
Ceded Reinsurance Premiums Payable	1,525,470,381	1,591,358,027
Securities Lending Collateral Liability	-	105,614,095
Other Liabilities	1,789,130,300	1,922,304,215
Total Liabilities	\$ 23,133,733,598	\$ 22,809,821,689
<b>Policyholders' Surplus:</b>		
Common Capital Stock	\$ 5,000,000	\$ 5,000,000
Paid-In and Contributed Surplus	4,394,131,321	4,394,131,321
Surplus Notes	-	-
Special Surplus Funds	3,996,000	9,672,000
Cumulative Unrealized Gain	172,586,977	192,450,057
Unassigned Surplus	3,310,681,195	2,579,853,368
Total Policyholders' Surplus	\$ 7,886,395,493	\$ 7,181,106,746
Total Liabilities and Policyholders' Surplus	\$ 31,020,129,090	\$ 29,990,928,434

I, LAURA J. LAZARCZYK, Corporate Secretary of ZURICH AMERICAN INSURANCE COMPANY do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company, on the 31st day of December, 2021, according to the best of my information, knowledge and belief.

DocuSigned by:

Laura J. Lazarczyk

420\*60847137480...

Corporate Secretary

State of Illinois  
 County of Cook

} SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15th day of March, 2022.



Notary public

**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND  
POWER OF ATTORNEY**

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Krista A. BURKE, Charo J. ROSEMOND, Maria L. SPADACCINI, Sherryanne M. DEPIRRO, Nicholas F. WALSH, Lisa M. SCAVETTA, James BALDASSARE, JR., John F. SURANO, Bianca L. MELI and Michael DUGAN of Saddle Brook, New Jersey**, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: **any and all bonds and undertakings**, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies, and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said **ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND**, this 8th day of December, A.D. 2022.



**ATTEST:**  
**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND**

By: *Robert D. Murray*  
Vice President

By: *Dawn E. Brown*  
Secretary

**State of Maryland  
County of Baltimore**

On this 8th day of December, A.D. 2022, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.

Iva Bethea  
Notary Public  
My Commission Expires September 30, 2023

**Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790**

**EXTRACT FROM BY-LAWS OF THE COMPANIES**

"Article V, Section 8, Attorneys-in-Fact. The Chief Executive Officer, the President, or any Executive Vice President or Vice President may, by written instrument under the attested corporate seal, appoint attorneys-in-fact with authority to execute bonds, policies, recognizances, stipulations, undertakings, or other like instruments on behalf of the Company, and may authorize any officer or any such attorney-in-fact to affix the corporate seal thereto; and may with or without cause modify or revoke any such appointment or authority at any time."

**CERTIFICATE**

I, the undersigned, Vice President of the ZURICH AMERICAN INSURANCE COMPANY, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing Power of Attorney is still in full force and effect on the date of this certificate; and I do further certify that Article V, Section 8, of the By-Laws of the Companies is still in force.

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the ZURICH AMERICAN INSURANCE COMPANY at a meeting duly called and held on the 15th day of December 1998.

RESOLVED: "That the signature of the President or a Vice President and the attesting signature of a Secretary or an Assistant Secretary and the Seal of the Company may be affixed by facsimile on any Power of Attorney...Any such Power or any certificate thereof bearing such facsimile signature and seal shall be valid and binding on the Company."

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at a meeting duly called and held on the 5th day of May, 1994, and the following resolution of the Board of Directors of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at a meeting duly called and held on the 10th day of May, 1990.

RESOLVED: "That the facsimile or mechanically reproduced seal of the company and facsimile or mechanically reproduced signature of any Vice-President, Secretary, or Assistant Secretary of the Company, whether made heretofore or hereafter, wherever appearing upon a certified copy of any power of attorney issued by the Company, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this 13th day of March, 2023.



*MJ Pethick*

By: Mary Jean Pethick  
Vice President

**TO REPORT A CLAIM WITH REGARD TO A SURETY BOND, PLEASE SUBMIT A COMPLETE DESCRIPTION OF THE CLAIM INCLUDING THE PRINCIPAL ON THE BOND, THE BOND NUMBER, AND YOUR CONTACT INFORMATION TO:**

Zurich Surety Claims  
1299 Zurich Way  
Schaumburg, IL 60196-1056  
Ph: 800-626-4577

If your jurisdiction allows for electronic reporting of surety claims, please submit to:  
[reportsfclaims@zurichna.com](mailto:reportsfclaims@zurichna.com)

**Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790**

**FEDERAL INSURANCE COMPANY**  
**STATEMENT OF ASSETS, LIABILITIES AND SURPLUS TO POLICYHOLDERS**

Statutory Basis

December 31, 2021

(in thousands)

ASSETS		LIABILITIES AND SURPLUS TO POLICYHOLDERS	
Cash and Short Term Investments	\$ (587,308)	Outstanding Losses and Loss Expenses	\$ 8,701,383
United States Government, State and Municipal Bonds	4,271,534	Reinsurance Payable on Losses and Expenses	1,484,196
Other Bonds	5,994,873	Unearned Premiums	2,400,711
Stocks	875,588	Ceded Reinsurance Premiums Payable	388,332
Other Invested Assets	<u>1,847,712</u>	Other Liabilities	<u>498,472</u>
<b>TOTAL INVESTMENTS</b>	<b><u>12,022,201</u></b>	<b>TOTAL LIABILITIES</b>	<b><u>13,451,084</u></b>
Investments in Affiliates:		Capital Stock	20,980
Great Northern Ins. Co.	414,838	Paid-In Surplus	2,711,474
Vigilant Ins. Co.	354,696	Unassigned Funds	<u>1,903,522</u>
Chubb Indemnity Ins. Co.	183,242	<b>SURPLUS TO POLICYHOLDERS</b>	<b><u>4,835,978</u></b>
Chubb National Ins. Co.	190,801		
Other Affiliates	116,373		
Premiums Receivable	1,726,853		
Other Assets	<u>3,078,466</u>		
 		<b>TOTAL LIABILITIES AND SURPLUS</b>	<b><u>\$18,087,070</u></b>
<b>TOTAL ADMITTED ASSETS</b>	<b><u>\$ 18,087,070</u></b>		

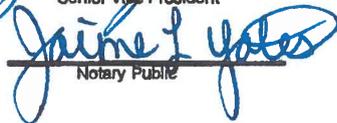
Investments are valued in accordance with requirements of the National Association of Insurance Commissioners. At December 31, 2021, investments with a carrying value of \$509,085,162 were deposited with government authorities as required by law.

STATE OF PENNSYLVANIA  
 COUNTY OF PHILADELPHIA

John Taylor, being duly sworn, says that he is Senior Vice President of Federal Insurance Company and that to the best of his knowledge and belief the foregoing is a true and correct statement of the said Company's financial condition as of the 31 st day of December, 2021.

Sworn before me this March 16, 2022

  
 Senior Vice President

  
 Notary Public

September 19, 2023  
 My commission expires

Commonwealth of Pennsylvania - Notary Seal  
 Jaime L. Yates, Notary Public  
 Philadelphia County  
 My commission expires September 19, 2023  
 Commission number 1357070  
 Member, Pennsylvania Association of Notaries



Power of Attorney

Federal Insurance Company | Vigilant Insurance Company | Pacific Indemnity Company  
Westchester Fire Insurance Company | ACE American Insurance Company

Know All by These Presents, that FEDERAL INSURANCE COMPANY, an Indiana corporation, VIGILANT INSURANCE COMPANY, a New York corporation, PACIFIC INDEMNITY COMPANY, a Wisconsin corporation, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint James Baldassare Jr., Krista A. Burke, Sherryanne M. DePirro, Michael Dugan, Bianca L. Meli, Charo J. Rosemond, Lisa M. Scavetta, Maria L. Spadaccini, John F. Surano and Nicholas F. Walsh of Saddle Brook, New Jersey

each as their true and lawful Attorney-in-Fact to execute under such designation in their names and to affix their corporate seals to and deliver for and on their behalf as surety thereon or otherwise, bonds and undertakings and other writings obligatory in the nature thereof (other than bail bonds) given or executed in the course of business, and any instruments amending or altering the same, and consents to the modification or alteration of any instrument referred to in said bonds or obligations.

In Witness Whereof, said FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY have each executed and attested these presents and affixed their corporate seals on this 8th day of December, 2022.

*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

*Stephen M. Haney*

Stephen M. Haney, Vice President



STATE OF NEW JERSEY  
County of Hunterdon

SS.

On this 8th day of December, 2022 before me, a Notary Public of New Jersey, personally came Dawn M. Chloros and Stephen M. Haney, to me known to be Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros and Stephen M. Haney, being by me duly sworn, severally and each for herself and himself did depose and say that they are Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and know the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that their signatures as such officers were duly affixed and subscribed by like authority.

Notarial Seal



Albert Contursi  
NOTARY PUBLIC OF NEW JERSEY  
No 50202369  
Commission Expires August 22, 2027

*Albert Contursi*  
Notary Public

CERTIFICATION

Resolutions adopted by the Boards of Directors of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY on August 30, 2016; WESTCHESTER FIRE INSURANCE COMPANY on December 11, 2006; and ACE AMERICAN INSURANCE COMPANY on March 20, 2009:

"RESOLVED, that the following authorizations relate to the execution, for and on behalf of the Company, of bonds, undertakings, recognizances, contracts and other written commitments of the Company entered into in the ordinary course of business (each a "Written Commitment"):

- (1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.
- (2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.
- (3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

FURTHER RESOLVED, that the foregoing Resolution shall not be deemed to be an exclusive statement of the powers and authority of officers, employees and other persons to act for and on behalf of the Company, and such Resolution shall not limit or otherwise affect the exercise of any such power or authority otherwise validly granted or vested."

I, Dawn M. Chloros, Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY (the "Companies") do hereby certify that

- (i) the foregoing Resolutions adopted by the Board of Directors of the Companies are true, correct and in full force and effect,
- (ii) the foregoing Power of Attorney is true, correct and in full force and effect.

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this 13th March 2023



*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

IN THE EVENT YOU WISH TO VERIFY THE AUTHENTICITY OF THIS BOND OR NOTIFY US OF ANY OTHER MATTER, PLEASE CONTACT US AT:  
Telephone (908) 903-3493 Fax (908) 903-3656 e-mail: surety@chubb.com

**THE CONTINENTAL INSURANCE COMPANY**  
**Radnor, Pennsylvania**  
**Statement of Net Admitted Assets and Liabilities**  
**December 31, 2021**

ASSETS

Bonds	\$ 1,572,724,833
Stocks	150,045,249
Cash and short-term investments	61,182,427
Receivables for securities	225,982
Investment income due and accrued	15,250,861
Amounts recoverable from reinsurers	66,552,237
Funds held by or deposited with reinsured companies	1,516,010
Current federal and foreign income tax recoverable and interest thereon	125
Net deferred tax asset	45,133,624
Premiums and considerations	67,900,494
Other assets	7,961,311
Total Assets	<u>\$ 1,988,493,153</u>

LIABILITIES AND SURPLUS

Losses	\$ 542,200,023
Loss adjustment expense	35,284,859
Unearned premiums	-
Other expenses	-
Federal and foreign income taxes payable	-
Ceded reinsurance premiums payable (net of ceding commissions)	57,149,295
Funds held by company under reinsurance treaties	5,172,467
Provision for reinsurance	26,200,000
Other liabilities	(489,610,082)
Total Liabilities	<u>\$ 176,396,562</u>

Surplus Account:

Capital paid up	\$ 53,566,360
Gross paid in and contributed surplus	1,423,436,994
Special Surplus	329,535,224
Unassigned funds	<u>5,558,013</u>
Surplus as regards policyholders	<u>\$ 1,812,096,591</u>
Total Liabilities and Capital	<u>\$ 1,988,493,153</u>

I, Julie Lee, Assistant Vice President of Continental Insurance Company hereby certify that the above is an accurate representation of the financial statement of the Company dated December 31, 2021, as filed with the various Insurance Departments and is a true and correct statement of the condition of Continental Insurance Company as of that date.



THE CONTINENTAL INSURANCE COMPANY

By Julie Lee  
Assistant Vice President, External Reporting

Subscribed and sworn to me this 14th day of March, 2022.

My commission expires:



By Christopher Lopatowski  
Notary Public

**POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT**

**Know All Men By These Presents**, That The Continental Insurance Company, a Pennsylvania insurance company, is a duly organized and existing insurance company having its principal office in the City of Chicago, and State of Illinois, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

**Maria L Spadaccini, James Baldassare Jr, Michael Dugan, Krista A Burke, Charo J Rosemond, Sherryanne M DePirro, John F Surano, Bianca L Meli, Lisa M Scavetta, Nicholas F Walsh, Individually**

of Saddle Brook, NJ, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

**- In Unlimited Amounts -**

and to bind them thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the insurance company and all the acts of said Attorney, pursuant to the authority hereby given is hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law and Resolutions, printed on the reverse hereof, duly adopted, as indicated, by the Board of Directors of the insurance company.

**In Witness Whereof**, The Continental Insurance Company has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 7th day of September, 2022.

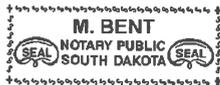


The Continental Insurance Company

*Paul T. Bruflat*  
Paul T. Bruflat Vice President

State of South Dakota, County of Minnehaha, ss:

On this 7th day of September, 2022, before me personally came Paul T. Bruflat to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is a Vice President of The Continental Insurance Company, a Pennsylvania insurance company, described in and which executed the above instrument; that he knows the seal of said insurance company; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said insurance company and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said insurance company.



My Commission Expires March 2, 2026

*M. Bent*  
M. Bent Notary Public

**CERTIFICATE**

I, D. Johnson, Assistant Secretary of The Continental Insurance Company, a Pennsylvania insurance company, do hereby certify that the Power of Attorney herein above set forth is still in force, and further certify that the By-Law and Resolution of the Board of Directors of the insurance company printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said insurance company this 13th day of March 2023



The Continental Insurance Company

*D. Johnson*  
D. Johnson Assistant Secretary

Form F6850-4/2012

Go to [www.cnasurety.com](http://www.cnasurety.com) > Owner / Obligee Services > Validate Bond Coverage, if you want to verify bond authenticity.

## Authorizing By-Laws and Resolutions

ADOPTED BY THE BOARD OF DIRECTORS OF THE CONTINENTAL INSURANCE COMPANY:

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the Board of Directors of the Company at a meeting held on May 10, 1995.

“RESOLVED: That any Group Vice President may authorize an officer to sign specific documents, agreements and instruments on behalf of the Company provided that the name of such authorized officer and a description of the documents, agreements or instruments that such officer may sign will be provided in writing by the Group Vice President to the Secretary of the Company prior to such execution becoming effective.

This Power of Attorney is signed by Paul T. Bruflat, Vice President, who has been authorized pursuant to the above resolution to execution power of attorneys on behalf of The Continental Insurance Company.

This Power of Attorney is signed and sealed by facsimile under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 25<sup>th</sup> day of April, 2012.

“Whereas, the bylaws of the Company or specific resolution of the Board of Directors has authorized various officers (the “Authorized Officers”) to execute various policies, bonds, undertakings and other obligatory instruments of like nature; and

Whereas, from time to time, the signature of the Authorized Officers, in addition to being provided in original, hard copy format, may be provided via facsimile or otherwise in an electronic format (collectively, “Electronic Signatures”), Now therefore be it resolved: that the Electronic Signature of any Authorized Officer shall be valid and binding on the Company.”

# BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY

1314 Douglas Street, Suite 1400, Omaha, Nebraska 68102-1944

## ADMITTED ASSETS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Total invested assets	\$ 6,504,184,299	\$ 5,475,240,588	\$ 5,172,183,338
Premium & agent balances (n	552,510,359	603,615,506	368,086,012
All other assets	142,765,038	157,897,676	127,524,677
<b>Admitted Assets</b>	<b>\$ 7,199,459,697</b>	<b>\$ 6,236,753,770</b>	<b>\$ 5,667,794,027</b>

## LIABILITIES & SURPLUS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Loss & loss exp. unpaid	\$ 1,142,116,028	\$ 921,923,948	\$ 634,745,558
Unearned premiums	484,660,143	372,836,160	314,117,549
All other liabilities	1,163,007,684	1,054,922,210	744,738,458
<b>Total Liabilities</b>	<b>2,789,783,855</b>	<b>2,349,682,318</b>	<b>1,693,601,565</b>
<b>Total Policyholders' Surplus:</b>	<b>4,409,675,842</b>	<b>3,887,071,452</b>	<b>3,974,192,463</b>
<b>Total Liabilities &amp; Surplus</b>	<b>\$ 7,199,459,697</b>	<b>\$ 6,236,753,770</b>	<b>\$ 5,667,794,028</b>

\* Assets, liabilities and surplus are presented on a Statutory Accounting Basis as promulgated by the NAIC and/or the laws of the company's domiciliary state.



### Power Of Attorney

#### BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY NATIONAL INDEMNITY COMPANY / NATIONAL LIABILITY & FIRE INSURANCE COMPANY

Know all men by these presents, that **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at One Lincoln Street, 23rd Floor, Boston, Massachusetts 02111, **NATIONAL INDEMNITY COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at 3024 Harney Street, Omaha, Nebraska 68131 and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Connecticut and having an office at 100 First Stamford Place, Stamford, Connecticut 06902 (hereinafter collectively the "Companies"), pursuant to and by the authority granted as set forth herein, do hereby name, constitute and appoint: **Lisa M. Scavetta, Sherryanne M. DePirro, Maria L. Spadaccini, Nicholas F. Walsh, James Baldassare, Jr., Krista A. Burke, Charo J. Rosemond, John F. Surano, Bianca L. Meli, Michael Dugan, 250 Pehle Avenue, Suite 311 of the city of Saddle Brook, State of New Jersey**, their true and lawful attorney(s)-in-fact to make, execute, seal, acknowledge, and deliver, for and on their behalf as surety and as their act and deed, any and all undertakings, bonds, or other such writings obligatory in the nature thereof, in pursuance of these presents, the execution of which shall be as binding upon the Companies as if it has been duly signed and executed by their regularly elected officers in their own proper persons. **This authority for the Attorney-in-Fact shall be limited to the execution of the attached bond(s) or other such writings obligatory in the nature thereof.**

In witness whereof, this Power of Attorney has been subscribed by an authorized officer of the Companies, and the corporate seals of the Companies have been affixed hereto this date of December 20, 2018. This Power of Attorney is made and executed pursuant to and by authority of the Bylaws, Resolutions of the Board of Directors, and other Authorizations of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY and NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, which are in full force and effect, each reading as appears on the back page of this Power of Attorney, respectively. **The following signature by an authorized officer of the Company may be a facsimile, which shall be deemed the equivalent of and constitute the written signature of such officer of the Company for all purposes regarding this Power of Attorney, including satisfaction of any signature requirements on any and all undertakings, bonds, or other such writings obligatory in the nature thereof, to which this Power of Attorney applies.**

**BERKSHIRE HATHAWAY SPECIALTY  
INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Executive Vice President



**NATIONAL INDEMNITY COMPANY,  
NATIONAL LIABILITY & FIRE INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Vice President

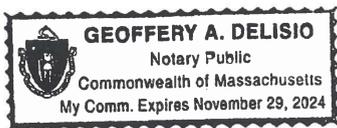


**NOTARY**

State of Massachusetts, County of Suffolk, ss:

On this 20th day of December, 2018, before me appeared David Fields, Executive Vice President of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY** and Vice President of **NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, who being duly sworn, says that his capacity is as designated above for such Companies; that he knows the corporate seals of the Companies; that the seals affixed to the foregoing instrument are such corporate seals; that they were affixed by order of the board of directors or other governing body of said Companies pursuant to its Bylaws, Resolutions and other Authorizations, and that he signed said instrument in that capacity of said Companies.

[Notary Seal]



Notary Public

I, Ralph Tortorella, the undersigned, Officer of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY and NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies which is in full force and effect and has not been revoked. IN TESTIMONY WHEREOF, see hereunto affixed the seals of said Companies this March 13, 2023.



Officer

To verify the authenticity of this Power of Attorney please contact us at: BHSI Surety Department, Berkshire Hathaway Specialty Insurance Company, One Lincoln Street, 23rd Floor Boston, MA 02111 | (770) 625-2516 or by email at [jennifer.porter@bhspecialty.com](mailto:jennifer.porter@bhspecialty.com). **THIS POWER OF ATTORNEY IS VOID IF ALTERED**  
To notify us of a claim please contact us on our 24-hour toll free number at (855) 453-9675, via email at [claimsnotice@bhspecialty.com](mailto:claimsnotice@bhspecialty.com), via fax to (617) 507-8259, or via mail.

**BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY (BYLAWS)**

ARTICLE V.

CORPORATE ACTIONS

....

EXECUTION OF DOCUMENTS:

....

Section 6.(b) The President, any Vice President or the Secretary, shall have the power and authority:

- (1) To appoint Attorneys-in-fact, and to authorize them to execute on behalf of the Company bonds and other undertakings, and
- (2) To remove at any time any such Attorney-in-fact and revoke the authority given him.

**NATIONAL INDEMNITY COMPANY (BY-LAWS)**

Section 1. Officers, Agents, and Employees:

A. The officers shall be a President, one or more Vice Presidents, a Secretary, one or more Assistant Secretaries, a Treasurer, and one or more Assistant Treasurers none of whom shall be required to be shareholders or Directors and each of whom shall be elected annually by the Board of Directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the Board of Directors, and shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the Board of Directors; and the Board of Directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the corporation.

**NATIONAL INDEMNITY COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BY-LAWS)**

ARTICLE IV

Officers

Section 1. Officers, Agents and Employees:

A. The officers shall be a president, one or more vice presidents, one or more assistant vice presidents, a secretary, one or more assistant secretaries, a treasurer, and one or more assistant treasurers, none of whom shall be required to be shareholders or directors, and each of whom shall be elected annually by the board of directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the board of directors. The president and secretary shall be different individuals. Election or appointment of an officer or agent shall not create contract rights. The officers of the Corporation shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the board of directors; and the board of directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the Corporation.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.

Liberty Bond No. 015219985  
Travelers Bond No. 107766496  
F&D/Zurich Bond No. 9416629  
Federal Bond No. K41614225  
Continental Bond No. 30172839  
Berkshire Bond No. 47-SUR-300033-01-0702

**PAYMENT BOND**

**KNOW ALL MEN BY THESE PRESENTS**, that we, the undersigned Flatiron Constructors, Inc., a corporation organized under the laws of the State of Delaware, hereinafter referred to as the "Contractor" and SEE ATTACHMENT A, a corporation organized under the laws of the State of SEE ATTACHMENT A, and authorized to transact business in the State of Colorado, hereinafter referred to as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", in the penal sum of Sixty Million, Four Hundred Sixty-One Thousand, Seven Hundred Seventy and 05/100 Dollars (\$ 60,461,770.05), lawful money of the United States of America, for the payment of which sum the Contractor and Surety bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

**WHEREAS**, the above Contractor has entered into a written contract with the City for furnishing all labor, materials, tools, superintendence, and other facilities and accessories for the construction of Contract No. IFB No. 202366450, Taxiway DS East and Deicing Pad, at Denver International Airport, in accordance with the Technical Specifications, Contract Drawings and all other Contract Documents therefor which are incorporated herein by reference and made a part hereof, and are herein referred to as the Contract.

**NOW, THEREFORE**, the condition of this payment bond obligation is such that if the Contractor shall at all times promptly make payments of all amounts lawfully due to all persons supplying or furnishing it or its subcontractors with labor and materials, rental machinery, tools, or equipment, used or performed in the prosecution of work provided for in the above Contract and shall indemnify and save harmless the City to the extent of any and all payments in connection with the carrying out of such Contract which the City may be required to make under the law, then this obligation shall be null and void, otherwise, it shall remain in full force and effect;

**PROVIDED FURTHER**, that the said Surety, for value received, hereby stipulates and agrees that any and all changes in the Contract, or compliance or noncompliance with the formalities in the Contract for making such changes shall not affect the Surety's obligations under this bond and the Surety hereby waives notice of any such changes.

[END OF PAGE]

IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 13th day of March, 2023.

By:   
KEVIN McCORMICK  
DIVISION FINANCE MANAGER



Flatiron Constructors, Inc.  
CONTRACTOR

By:   
President GRANT JOHNS  
VICE PRESIDENT

SEE ATTACHMENT A  
SURETY

By: SEE ATTACHMENT A  
Attorney-in-Fact

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond.)

CITY AND COUNTY OF DENVER

By:   
MAYOR

By:   
Chief Executive Officer  
Denver International Airport

APPROVED AS TO FORM:

KERRY TIPPER, Attorney for the City  
and County of Denver

By:   
Assistant City Attorney

## ATTACHMENT A

Liberty Mutual Insurance Company, a Massachusetts Corporation  
Travelers Casualty and Surety Company of America, a Connecticut corporation  
Fidelity and Deposit Company of Maryland, an Illinois corporation  
Zurich American Insurance Company, a New York corporation  
Federal Insurance Company, an Indiana corporation  
The Continental Insurance Company, a Pennsylvania Corporation  
Berkshire Specialty Insurance Company, a Nebraska Corporation

**Liberty Mutual Insurance Company – A.M. Best Rating A XV; NAIC# 23043**

175 Berkeley Street, Boston, MA 02116; Tel.: (212) 719-7750; Fax (212) 221-5608  
Contact: David D. Roberts, Branch Manager, [davidd.roberts@libertymutual.com](mailto:davidd.roberts@libertymutual.com)

**Mailing Address for Claims Notices:**

Sam E. Barker, Director-AsiaPac, Global Risk Claims  
[Sam.barker@libertymutual.com](mailto:Sam.barker@libertymutual.com) or [HOSCL@Libertymutual.com](mailto:HOSCL@Libertymutual.com)

Safeco Plaza, 1001 4<sup>th</sup> Avenue, Suite 3800  
Seattle, WA 98154

**Bond No. 015219985**

**Travelers Casualty and Surety Company of America – A.M. Best Rating A++ XV; NAIC# 31194**

Construction Services, One Tower Square, Hartford, CT 06183; Tel.: (860) 277-1914; Fax (860) 277-3931  
Contact: Jacob Fulmer, Regional Underwriting Officer, [jfulmer1@travelers.com](mailto:jfulmer1@travelers.com)

**Bond No. 107766496**

**Fidelity and Deposit Company of Maryland - A.M. Best Rating A+ XV; NAIC# 39306**

**Zurich American Insurance Company - A.M. Best Rating A+ XV; NAIC# 16535**

1299 Zurich Way, 5<sup>th</sup> Floor, Schaumburg, IL 60196; Tel.: (410) 559-8739; Fax (410) 261-7957  
Contact: Douglas Sauer, Underwriting Officer, [douglas.sauer@zurichna.com](mailto:douglas.sauer@zurichna.com)

**Bond No. 9416629**

**Federal Insurance Company – A.M. Best Rating A++ XV; NAIC# 20281**

202B Hall's Mill Road, Whitehouse Station, NJ 08889; Tel.: (908) 903-4868; Fax (908) 903-3656  
Contact: Brock Masterson, Senior VP/Director Construction Surety, [brock.masterson@chubb.com](mailto:brock.masterson@chubb.com)

**Bond No. K41614225**

**The Continental Insurance Company – A.M. Best Rating A XV; NAIC# 35289**

151 N Franklin Street, Chicago, IL 60606; Tel.: (212) 440-7356; Fax (212) 440-7351  
Contact: Jon Fullerton, Branch Manager, [jon.fullerton@cnsurety.com](mailto:jon.fullerton@cnsurety.com)

**Bond No. 30172839**

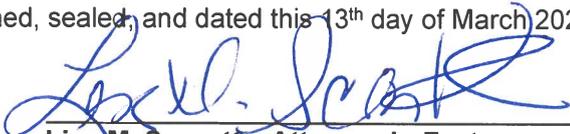
**Berkshire Specialty Insurance Company – A.M. Best Rating A++ XV; NAIC# 22276**

1314 Douglas Street, Suite 1400, Omaha, NE 68102; Tel.: (617) 936-2971; Fax (N/A)  
Contact: Courtney T. Walker, Senior Vice President Surety, [courtney.walker@bhspecialty.com](mailto:courtney.walker@bhspecialty.com)

**Bond No. 47-SUR-300033-01-0702**

Signed, sealed, and dated this 13<sup>th</sup> day of March 2023.

By:

  
\_\_\_\_\_  
**Lisa M. Scavetta, Attorney-In-Fact**

Turner Surety and Insurance Brokerage, Inc.  
250 Pehle Avenue, Suite 311, Saddle Brook, NJ 07663  
Office: 201-267-7507 | Fax: 201-267-7532  
Email: [lscavetta@tsibinc.com](mailto:lscavetta@tsibinc.com) | CA License # 0E81386

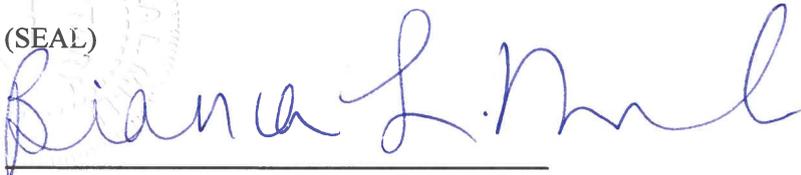
**CORPORATE ACKNOWLEDGMENT**

Form 152

STATE OF NEW JERSEY  
COUNTY OF BERGEN

On this 13<sup>th</sup> day of March, 2023 before me personally came Lisa M. Scavetta to me known, who, being by me duly sworn, did depose and say that she/he resides in Bronxville, New York that she/he is the ATTORNEY IN FACT of the LIBERTY MUTUAL INSURANCE COMPANY, TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, FIDELITY AND DEPOSIT COMPANY OF MARYLAND, ZURICH AMERICAN INSURANCE COMPANY, FEDERAL INSURANCE COMPANY, THE CONTINENTAL INSURANCE COMPANY, BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, the corporation described in and which executed the above instrument that she/he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that she/he signed her/his name thereto by like order.

(SEAL)



Bianca L. Meli

**BIANCA L. MELI**  
**NOTARY PUBLIC, STATE OF NEW JERSEY**  
**MY COMMISSION EXPIRES**  
**SEPTEMBER 30, 2024**



LIBERTY MUTUAL INSURANCE COMPANY  
FINANCIAL STATEMENT — DECEMBER 31, 2021

<b>Assets</b>		<b>Liabilities</b>	
Cash and Bank Deposits .....	\$2,234,770,744	Unearned Premiums .....	\$9,106,965,847
*Bonds — U.S Government .....	4,250,615,811	Reserve for Claims and Claims Expense .....	25,279,158,493
*Other Bonds .....	16,983,165,862	Funds Held Under Reinsurance Treaties .....	315,537,902
*Stocks .....	20,075,458,019	Reserve for Dividends to Policyholders .....	1,726,291
Real Estate .....	182,250,567	Additional Statutory Reserve .....	139,634,000
Agents' Balances or Uncollected Premiums .....	7,607,687,836	Reserve for Commissions, Taxes and Other Liabilities .....	8,638,106,801
Accrued Interest and Rents .....	120,173,987	<b>Total .....</b>	<b>\$43,481,129,334</b>
Other Admitted Assets .....	14,076,622,575	Special Surplus Funds .....	\$178,192,363
		Capital Stock .....	10,000,075
		Paid in Surplus .....	11,804,736,755
		Unassigned Surplus .....	10,056,686,874
<b>Total Admitted Assets .....</b>	<b><u>\$65,530,745,401</u></b>	<b>Surplus to Policyholders .....</b>	<b>22,049,616,067</b>
		<b>Total Liabilities and Surplus .....</b>	<b><u>\$65,530,745,401</u></b>



\* Bonds are stated at amortized or investment value; Stocks at Association Market Values.  
The foregoing financial information is taken from Liberty Mutual Insurance Company's financial statement filed with the state of Massachusetts Department of Insurance.

I, TIM MIKOLAJEWSKI, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the foregoing is a true, and correct statement of the Assets and Liabilities of said Corporation, as of December 31, 2021, to the best of my knowledge and belief.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Corporation at Seattle, Washington, this 8<sup>th</sup> day of March, 2022.

*TAMIKOLAJEWSKI*

Assistant Secretary



This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

Certificate No: 8208613-974450

POWER OF ATTORNEY

KNOWN ALL PERSONS BY THESE PRESENTS: That The Ohio Casualty Insurance Company is a corporation duly organized under the laws of the State of New Hampshire, that Liberty Mutual Insurance Company is a corporation duly organized under the laws of the State of Massachusetts, and West American Insurance Company is a corporation duly organized under the laws of the State of Indiana (herein collectively called the "Companies"), pursuant to and by authority herein set forth, does hereby name, constitute and appoint, Bianca L. Meli; Charo J. Rosemond; James Baldassare, Jr.; John F. Surano; Krista A. Burke; Lisa M. Scavetta; Maria L. Spadaccini; Michael Dugan; Nicholas F. Walsh; Sheryyanne M. DePirro

all of the city of Saddle Brook state of NJ each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents and shall be as binding upon the Companies as if they have been duly signed by the president and attested by the secretary of the Companies in their own proper persons.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Companies and the corporate seals of the Companies have been affixed thereto this 18th day of August, 2022.



Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

By: David M. Carey
David M. Carey, Assistant Secretary

State of PENNSYLVANIA
County of MONTGOMERY ss

On this 18th day of August, 2022 before me personally appeared David M. Carey, who acknowledged himself to be the Assistant Secretary of Liberty Mutual Insurance Company, The Ohio Casualty Company, and West American Insurance Company, and that he, as such, being authorized so to do, execute the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.



Commonwealth of Pennsylvania - Notary Seal
Teresa Pastella, Notary Public
Montgomery County
My commission expires March 28, 2025
Commission number 1126044
Member, Pennsylvania Association of Notaries

By: Teresa Pastella
Teresa Pastella, Notary Public

This Power of Attorney is made and executed pursuant to and by authority of the following By-laws and Authorizations of The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company which resolutions are now in full force and effect reading as follows:

ARTICLE IV - OFFICERS: Section 12. Power of Attorney.

Any officer or other official of the Corporation authorized for that purpose in writing by the Chairman or the President, and subject to such limitation as the Chairman or the President may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Corporation to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Corporation by their signature and execution of any such instruments and to attach thereto the seal of the Corporation. When so executed, such instruments shall be as binding as if signed by the President and attested to by the Secretary. Any power or authority granted to any representative or attorney-in-fact under the provisions of this article may be revoked at any time by the Board, the Chairman, the President or by the officer or officers granting such power or authority.

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.

Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

Certificate of Designation - The President of the Company, acting pursuant to the Bylaws of the Company, authorizes David M. Carey, Assistant Secretary to appoint such attorneys-in-fact as may be necessary to act on behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

Authorization - By unanimous consent of the Company's Board of Directors, the Company consents that facsimile or mechanically reproduced signature of any assistant secretary of the Company, wherever appearing upon a certified copy of any power of attorney issued by the Company in connection with surety bonds, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

I, Renee C. Llewellyn, the undersigned, Assistant Secretary, The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy of the Power of Attorney executed by said Companies, is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 13th day of March, 2023.



By: Renee C. Llewellyn
Renee C. Llewellyn, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, currency rate, interest rate or residual value guarantees.

For bond and/or Power of Attorney (POA) verification inquiries, please call 610-893-8240 or email LOCI@libertymutual.com

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA

HARTFORD, CONNECTICUT 06183

FINANCIAL STATEMENT AS OF DECEMBER 31, 2021

CAPITAL STOCK \$ 6,480,000

ASSETS		LIABILITIES & SURPLUS	
BONDS	\$ 4,427,068,873	LOSSES	\$ 1,224,258,147
STOCKS	90,892,083	LOSS ADJUSTMENT EXPENSES	157,266,812
CASH AND INVESTED CASH	3,976,380	COMMISSIONS	49,977,644
OTHER INVESTED ASSETS	4,609,133	OTHER EXPENSES	46,607,590
SECURITIES LENDING REINVESTED COLLATERAL ASSETS	7,433,086	TAXES, LICENSES AND FEES	16,655,025
INVESTMENT INCOME DUE AND ACCRUED	37,877,324	CURRENT FEDERAL AND FOREIGN INCOME TAXES	1,972,277
PREMIUM BALANCES	294,081,729	UNEARNED PREMIUMS	1,212,347,629
REINSURANCE RECOVERABLE	70,677,646	ADVANCE PREMIUM	1,824,313
NET DEFERRED TAX ASSET	60,156,960	POLICYHOLDER DIVIDENDS	14,256,052
OTHER ASSETS	3,286,703	CEDED REINSURANCE NET PREMIUMS PAYABLE	47,473,619
		AMOUNTS WITHHELD / RETAINED BY COMPANY FOR OTHERS	42,097,038
		REMITTANCES AND ITEMS NOT ALLOCATED	10,579,448
		PROVISION FOR REINSURANCE	6,873,132
		PAYABLE TO PARENT, SUBSIDIARIES AND AFFILIATES	40,373,235
		PAYABLE FOR SECURITIES LENDING	7,433,086
		ESCHEAT LIABILITY	537,132
		RETROACTIVE REINSURANCE RESERVE ASSUMED	816,092
		OTHER ACCRUED EXPENSES AND LIABILITIES	250,005
		<b>TOTAL LIABILITIES</b>	<b>\$ 2,881,598,277</b>
		CAPITAL STOCK	\$ 6,480,000
		PAID IN SURPLUS	433,803,760
		OTHER SURPLUS	1,678,177,878
		<b>TOTAL SURPLUS TO POLICYHOLDERS</b>	<b>\$ 2,118,461,638</b>
<b>TOTAL ASSETS</b>	<b>\$ 5,000,059,915</b>	<b>TOTAL LIABILITIES &amp; SURPLUS</b>	<b>\$ 5,000,059,915</b>

STATE OF CONNECTICUT )  
 COUNTY OF HARTFORD ) SS.  
 CITY OF HARTFORD )

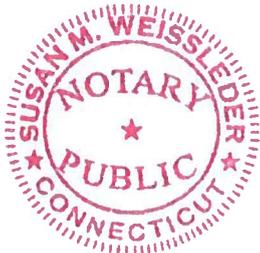
MICHAEL J. DOODY, BEING DULY SWORN, SAYS THAT HE IS VICE PRESIDENT - FINANCE, OF TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA, AND THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT STATEMENT OF THE FINANCIAL CONDITION OF SAID COMPANY AS OF THE 31ST DAY OF DECEMBER, 2021.

*Michael J. Doody*  
 VICE PRESIDENT - FINANCE

*Susan M. Weissleder*  
 NOTARY PUBLIC

SUBSCRIBED AND SWORN TO BEFORE ME THIS  
 17TH DAY OF MARCH, 2022

SUSAN M. WEISSLEDER  
 Notary Public  
 My Commission Expires November 30, 2022





**Travelers Casualty and Surety Company of America  
Travelers Casualty and Surety Company  
St. Paul Fire and Marine Insurance Company**

**POWER OF ATTORNEY**

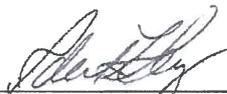
**KNOW ALL MEN BY THESE PRESENTS:** That Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company are corporations duly organized under the laws of the State of Connecticut (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint **Lisa M. Scavetta** of **SADDLE BROOK**, their true and lawful Attorney(s)-in-Fact to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

**IN WITNESS WHEREOF**, the Companies have caused this instrument to be signed, and their corporate seals to be hereto affixed, this **21st** day of **April**, 2021.



State of Connecticut

City of Hartford ss.

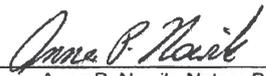
By:   
Robert L. Raney, Senior Vice President

On this the **21st** day of **April**, 2021, before me personally appeared **Robert L. Raney**, who acknowledged himself to be the Senior Vice President of each of the Companies, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of said Companies by himself as a duly authorized officer.

**IN WITNESS WHEREOF**, I hereunto set my hand and official seal.

My Commission expires the **30th** day of **June**, 2026



  
Anna P. Nowik, Notary Public

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of each of the Companies, which resolutions are now in full force and effect, reading as follows:

**RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

**FURTHER RESOLVED**, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

**FURTHER RESOLVED**, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

**FURTHER RESOLVED**, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, **Kevin E. Hughes**, the undersigned, Assistant Secretary of each of the Companies, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which remains in full force and effect.

Dated this **13th** day of **March**, 2023.



  
Kevin E. Hughes, Assistant Secretary

**To verify the authenticity of this Power of Attorney, please call us at 1-800-421-3880.  
Please refer to the above-named Attorney(s)-in-Fact and the details of the bond to which this Power of Attorney is attached.**

**THE FIDELITY AND DEPOSIT COMPANY**

OF MARYLAND  
1299 Zurich Way Schaumburg, IL 60196

**Statement of Financial Condition**  
As Of December 31, 2021

**ASSETS**

Bonds.....	\$ 237,467,504
Stocks .....	18,985,762
Cash and Short-Term Investments .....	7,415,852
Reinsurance Recoverable .....	25,735,324
Federal Income Tax Recoverable.....	0
Other Accounts Receivable.....	24,479,233
<b>TOTAL ADMITTED ASSETS.....</b>	<b>\$ 314,083,675</b>

**LIABILITIES, SURPLUS AND OTHER FUNDS**

Reserve for Taxes and Expenses .....	\$ 378,101
Ceded Reinsurance Premiums Payable .....	48,876,599
Remittances and Items Unallocated .....	0
Payable to parents, subs and affiliates.....	0
Securities Lending Collateral Liability.....	0
<b>TOTAL LIABILITIES .....</b>	<b>\$ 49,254,700</b>
Capital Stock, Paid Up .....	\$ 5,000,000
Surplus.....	264,828,975
Surplus as regards Policyholders.....	264,828,975
<b>TOTAL .....</b>	<b>\$ 314,083,675</b>

Securities carried at \$78,561,855 in the above statement are deposited with various states as required by law.

Securities carried on the basis prescribed by the National Association of Insurance Commissioners. On the basis of market quotations for all bonds and stocks owned, the Company's total admitted assets at December 31, 2021 would be \$319,561,762 and surplus as regards policyholders \$270,307,062.

I, LAURA J. LAZARCZYK, Corporate Secretary of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company on the 31st day of December, 2021.

DocuSigned by:  
*Laura J. Lazarczyk*  
42DF6DB47137486...  
Corporate Secretary

State of Illinois }  
City of Schaumburg } SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15<sup>th</sup> day of March, 2022.



*Ryan Horgan*  
Notary Public

**ZURICH AMERICAN INSURANCE COMPANY**  
**COMPARATIVE BALANCE SHEET**  
**4 WORLD TRADE CENTER, 150 GREENWICH STREET, NEW YORK, NY 10007**  
**As of December 31, 2021 and December 31, 2020**

<u>Assets</u>	<u>12/31/2021</u>	<u>12/31/2020</u>
Bonds	\$ 16,632,198,754	\$ 15,696,060,158
Preferred Stock	-	-
Common Stock	2,938,741,320	2,964,630,407
Real Estate	1,195,108,770	1,294,160,876
Other Invested Assets	1,511,224,849	1,435,120,966
Derivatives	4,892,042	178,175
Short-term Investments	562,958	285,002
Receivable for securities	22,712,596	809,339
Cash and cash equivalents	157,712,608	526,475,686
Securities lending reinvested collateral assets	-	105,614,095
Employee Trust for Deferred Compensation Plan	114,975,842	122,225,149
Total Cash and Invested Assets	<u>\$ 22,578,129,739</u>	<u>\$ 22,145,559,853</u>
Premiums Receivable	\$ 5,896,173,688	\$ 5,318,928,254
Funds Held with Reinsurers	-	99,875
Reinsurance Recoverable	1,288,549,705	1,248,855,148
Accrued Investment Income	118,060,365	118,531,136
Federal Income Tax Recoverable	471,599,585	507,200,404
Due from Affiliates	129,012,120	92,277,523
Other Assets	538,603,889	559,476,243
Total Assets	<u>\$ 31,020,129,090</u>	<u>\$ 29,990,928,434</u>
<u>Liabilities and Policyholders' Surplus</u>		
<u>Liabilities:</u>		
Loss and LAE Reserves	\$ 12,244,569,908	\$ 12,295,705,961
Unearned Premium Reserve	4,276,836,095	3,952,940,831
Funds Held with Reinsurers	674,404,810	554,226,440
Loss In Course of Payment	1,673,061,383	1,351,312,377
Commission Reserve	160,324,275	119,930,116
Federal Income Tax Payable	10,641,098	34,772,832
Remittances and Items Unallocated	336,655,509	432,727,110
Payable to parent, subs and affiliates	353,084,887	273,601,687
Provision for Reinsurance	89,554,951	175,327,995
Ceded Reinsurance Premiums Payable	1,525,470,381	1,591,358,027
Securities Lending Collateral Liability	-	105,614,095
Other Liabilities	1,789,130,300	1,922,304,215
Total Liabilities	<u>\$ 23,133,733,598</u>	<u>\$ 22,809,821,689</u>
<u>Policyholders' Surplus:</u>		
Common Capital Stock	\$ 5,000,000	\$ 5,000,000
Paid-In and Contributed Surplus	4,394,131,321	4,394,131,321
Surplus Notes	-	-
Special Surplus Funds	3,996,000	9,672,000
Cumulative Unrealized Gain	172,586,977	192,450,057
Unassigned Surplus	3,310,681,195	2,579,853,368
Total Policyholders' Surplus	<u>\$ 7,886,395,493</u>	<u>\$ 7,181,106,746</u>
Total Liabilities and Policyholders' Surplus	<u>\$ 31,020,129,090</u>	<u>\$ 29,990,928,434</u>

I, LAURA J. LAZARCZYK, Corporate Secretary of ZURICH AMERICAN INSURANCE COMPANY do hereby certify that the foregoing statement is a correct exhibit of the assets and liabilities of the said Company, on the 31st day of December, 2021, according to the best of my information, knowledge and belief.

DocuSigned by:

Laura J. Lazarczyk

42DF6DB47137480...

Corporate Secretary

State of Illinois  
 County of Cook

} SS:

Subscribed and sworn to, before me, a Notary Public of the State of Illinois, in the City of Schaumburg, this 15th day of March, 2022.

RYAN HORGAN  
 Official Seal  
 Notary Public - State of Illinois  
 My Commission Expires Dec 10, 2024

Notary public

**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND  
POWER OF ATTORNEY**

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Krista A. BURKE, Charo J. ROSEMOND, Maria L. SPADACCINI, Sherryanne M. DEPIRRO, Nicholas F. WALSH, Lisa M. SCAVETTA, James BALDASSARE, JR., John F. SURANO, Bianca L. MELI and Michael DUGAN of Saddle Brook, New Jersey**, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: **any and all bonds and undertakings**, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies, and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND, this 8th day of December, A.D. 2022.



**ATTEST:**  
ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND

By: *Robert D. Murray*  
Vice President

By: *Dawn E. Brown*  
Secretary

**State of Maryland  
County of Baltimore**

On this 8th day of December, A.D. 2022, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.

Iva Betha  
Notary Public  
My Commission Expires September 30, 2023

**Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790**

**EXTRACT FROM BY-LAWS OF THE COMPANIES**

"Article V, Section 8, Attorneys-in-Fact. The Chief Executive Officer, the President, or any Executive Vice President or Vice President may, by written instrument under the attested corporate seal, appoint attorneys-in-fact with authority to execute bonds, policies, recognizances, stipulations, undertakings, or other like instruments on behalf of the Company, and may authorize any officer or any such attorney-in-fact to affix the corporate seal thereto; and may with or without cause modify or revoke any such appointment or authority at any time."

**CERTIFICATE**

I, the undersigned, Vice President of the ZURICH AMERICAN INSURANCE COMPANY, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing Power of Attorney is still in full force and effect on the date of this certificate; and I do further certify that Article V, Section 8, of the By-Laws of the Companies is still in force.

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the ZURICH AMERICAN INSURANCE COMPANY at a meeting duly called and held on the 15th day of December 1998.

RESOLVED: "That the signature of the President or a Vice President and the attesting signature of a Secretary or an Assistant Secretary and the Seal of the Company may be affixed by facsimile on any Power of Attorney...Any such Power or any certificate thereof bearing such facsimile signature and seal shall be valid and binding on the Company."

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at a meeting duly called and held on the 5th day of May, 1994, and the following resolution of the Board of Directors of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at a meeting duly called and held on the 10th day of May, 1990.

RESOLVED: "That the facsimile or mechanically reproduced seal of the company and facsimile or mechanically reproduced signature of any Vice-President, Secretary, or Assistant Secretary of the Company, whether made heretofore or hereafter, wherever appearing upon a certified copy of any power of attorney issued by the Company, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this 13th day of March, 2023.



*MJ Pethick*

By: Mary Jean Pethick  
Vice President

**TO REPORT A CLAIM WITH REGARD TO A SURETY BOND, PLEASE SUBMIT A COMPLETE DESCRIPTION OF THE CLAIM INCLUDING THE PRINCIPAL ON THE BOND, THE BOND NUMBER, AND YOUR CONTACT INFORMATION TO:**

Zurich Surety Claims  
1299 Zurich Way  
Schauinburg, IL 60196-1056  
Ph: 800-626-4577

If your jurisdiction allows for electronic reporting of surety claims, please submit to:  
[reportsfclaims@zurichna.com](mailto:reportsfclaims@zurichna.com)

Authenticity of this bond can be confirmed at [bondvalidator.zurichna.com](http://bondvalidator.zurichna.com) or 410-559-8790

**FEDERAL INSURANCE COMPANY**  
**STATEMENT OF ASSETS, LIABILITIES AND SURPLUS TO POLICYHOLDERS**

Statutory Basis

December 31, 2021

(in thousands)

ASSETS		LIABILITIES AND SURPLUS TO POLICYHOLDERS	
Cash and Short Term Investments	\$ (587,306)	Outstanding Losses and Loss Expenses	\$ 8,701,383
United States Government, State and Municipal Bonds	4,271,534	Reinsurance Payable on Losses and Expenses	1,484,198
Other Bonds	5,984,873	Unearned Premiums	2,400,711
Stocks	675,588	Ceded Reinsurance Premiums Payable	388,332
Other Invested Assets	<u>1,647,712</u>	Other Liabilities	<u>488,472</u>
<b>TOTAL INVESTMENTS</b>	<b><u>12,022,201</u></b>	<b>TOTAL LIABILITIES</b>	<b><u>13,451,094</u></b>
Investments in Affiliates:		Capital Stock	20,980
Great Northern Ins. Co.	414,638	Paid-In Surplus	2,711,474
Vigilant Ins. Co.	354,698	Unassigned Funds	<u>1,903,522</u>
Chubb Indemnity Ins. Co.	183,242	<b>SURPLUS TO POLICYHOLDERS</b>	<b><u>4,635,978</u></b>
Chubb National Ins. Co.	190,801		
Other Affiliates	116,373		
Premiums Receivable	1,726,653		
Other Assets	<u>3,078,486</u>		
 		<b>TOTAL LIABILITIES AND SURPLUS</b>	<b><u>\$18,087,070</u></b>
<b>TOTAL ADMITTED ASSETS</b>	<b><u>\$ 18,087,070</u></b>		

Investments are valued in accordance with requirements of the National Association of Insurance Commissioners. At December 31, 2021, investments with a carrying value of \$508,085,182 were deposited with government authorities as required by law.

STATE OF PENNSYLVANIA  
 COUNTY OF PHILADELPHIA

John Taylor, being duly sworn, says that he is Senior Vice President of Federal Insurance Company and that to the best of his knowledge and belief the foregoing is a true and correct statement of the said Company's financial condition as of the 31 st day of December, 2021.

Sworn before me this March 16, 2022

  
 Senior Vice President

  
 Notary Public

September 19, 2023  
 My commission expires

Commonwealth of Pennsylvania - Notary Seal  
 Jaime L. Yates, Notary Public  
 Philadelphia County  
 My commission expires September 19, 2023  
 Commission number 1357070  
 Member, Pennsylvania Association of Notaries



Power of Attorney

Federal Insurance Company | Vigilant Insurance Company | Pacific Indemnity Company  
Westchester Fire Insurance Company | ACE American Insurance Company

Know All These Presents, that FEDERAL INSURANCE COMPANY, an Indiana corporation, VIGILANT INSURANCE COMPANY, a New York corporation, PACIFIC INDEMNITY COMPANY, a Wisconsin corporation, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint James Baldassare Jr., Krista A. Burke, Sherryanne M. DePirro, Michael Dugan, Bianca L. Meli, Charo J. Rosemond, Lisa M. Scavetta, Maria L. Spadaccini, John F. Surano and Nicholas F. Walsh of Saddle Brook, New Jersey -----

each as their true and lawful Attorney-in-Fact to execute under such designation in their names and to affix their corporate seals to and deliver for and on their behalf as surety thereon or otherwise, bonds and undertakings and other writings obligatory in the nature thereof (other than bail bonds) given or executed in the course of business, and any instruments amending or altering the same, and consents to the modification or alteration of any instrument referred to in said bonds or obligations.

In Witness Whereof, said FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY have each executed and attested these presents and affixed their corporate seals on this 8<sup>th</sup> day of December, 2022.

*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

*Stephen M. Haney*

Stephen M. Haney, Vice President



STATE OF NEW JERSEY  
County of Hunterdon ss.

On this 8<sup>th</sup> day of December, 2022 before me, a Notary Public of New Jersey, personally came Dawn M. Chloros and Stephen M. Haney, to me known to be Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros and Stephen M. Haney, being by me duly sworn, severally and each for herself and himself did depose and say that they are Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and know the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that their signatures as such officers were duly affixed and subscribed by like authority.

Notarial Seal



Albert Contursi  
NOTARY PUBLIC OF NEW JERSEY  
No 50202369  
Commission Expires August 22, 2027

*Albert Contursi*  
Notary Public

CERTIFICATION

Resolutions adopted by the Boards of Directors of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY on August 30, 2016; WESTCHESTER FIRE INSURANCE COMPANY on December 11, 2006; and ACE AMERICAN INSURANCE COMPANY on March 20, 2009:

"RESOLVED, that the following authorizations relate to the execution, for and on behalf of the Company, of bonds, undertakings, recognizances, contracts and other written commitments of the Company entered into in the ordinary course of business (each a "Written Commitment"):

- (1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.
- (2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.
- (3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.
- (5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

FURTHER RESOLVED, that the foregoing Resolution shall not be deemed to be an exclusive statement of the powers and authority of officers, employees and other persons to act for and on behalf of the Company, and such Resolution shall not limit or otherwise affect the exercise of any such power or authority otherwise validly granted or vested."

I, Dawn M. Chloros, Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY (the "Companies") do hereby certify that

- (i) the foregoing Resolutions adopted by the Board of Directors of the Companies are true, correct and in full force and effect,
- (ii) the foregoing Power of Attorney is true, correct and in full force and effect.

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this 13<sup>th</sup> March 2023



*Dawn M. Chloros*

Dawn M. Chloros, Assistant Secretary

IN THE EVENT YOU WISH TO VERIFY THE AUTHENTICITY OF THIS BOND OR NOTIFY US OF ANY OTHER MATTER, PLEASE CONTACT US AT:  
Telephone (908) 903-3493 Fax (908) 903-3656 e-mail: surety@chubb.com

**THE CONTINENTAL INSURANCE COMPANY**  
**Radnor, Pennsylvania**  
**Statement of Net Admitted Assets and Liabilities**  
**December 31, 2021**

ASSETS

Bonds	\$ 1,572,724,833
Stocks	150,045,249
Cash and short-term investments	61,182,427
Receivables for securities	225,982
Investment income due and accrued	15,250,861
Amounts recoverable from reinsurers	66,552,237
Funds held by or deposited with reinsured companies	1,516,010
Current federal and foreign income tax recoverable and interest thereon	125
Net deferred tax asset	45,133,624
Premiums and considerations	67,900,494
Other assets	7,961,311
<b>Total Assets</b>	<u>\$ 1,988,493,153</u>

LIABILITIES AND SURPLUS

Losses	\$ 542,200,023
Loss adjustment expense	35,284,859
Unearned premiums	-
Other expenses	-
Federal and foreign income taxes payable	-
Ceded reinsurance premiums payable (net of ceding commissions)	57,149,295
Funds held by company under reinsurance treaties	5,172,467
Provision for reinsurance	26,200,000
Other liabilities	(489,610,082)
<b>Total Liabilities</b>	<u>\$ 176,396,562</u>

Surplus Account:

Capital paid up	\$ 53,566,360
Gross paid in and contributed surplus	1,423,436,994
Special Surplus	329,535,224
Unassigned funds	5,558,013
Surplus as regards policyholders	<u>\$ 1,812,096,591</u>
<b>Total Liabilities and Capital</b>	<u>\$ 1,988,493,153</u>

I, Julie Lee, Assistant Vice President of Continental Insurance Company hereby certify that the above is an accurate representation of the financial statement of the Company dated December 31, 2021, as filed with the various Insurance Departments and is a true and correct statement of the condition of Continental Insurance Company as of that date.



THE CONTINENTAL INSURANCE COMPANY

By Julie Lee  
 Assistant Vice President, External Reporting

Subscribed and sworn to me this 14th day of March, 2022.

My commission expires:



By Christopher Lopatowski  
 Notary Public

**POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT**

**Know All Men By These Presents**, That The Continental Insurance Company, a Pennsylvania insurance company, is a duly organized and existing insurance company having its principal office in the City of Chicago, and State of Illinois, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

**Maria L Spadaccini, James Baldassare Jr, Michael Dugan, Krista A Burke, Charo J Rosemond, Sherryanne M DePirro, John F Surano, Bianca L Meli, Lisa M Scavetta, Nicholas F Walsh, Individually**

of Saddle Brook, NJ, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

**- In Unlimited Amounts -**

and to bind them thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the insurance company and all the acts of said Attorney, pursuant to the authority hereby given is hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law and Resolutions, printed on the reverse hereof, duly adopted, as indicated, by the Board of Directors of the insurance company.

**In Witness Whereof**, The Continental Insurance Company has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 7th day of September, 2022.

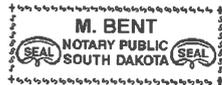


The Continental Insurance Company

*Paul T. Bruflat*  
Paul T. Bruflat Vice President

State of South Dakota, County of Minnehaha, ss:

On this 7th day of September, 2022, before me personally came Paul T. Bruflat to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is a Vice President of The Continental Insurance Company, a Pennsylvania insurance company, described in and which executed the above instrument; that he knows the seal of said insurance company; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said insurance company and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said insurance company.



My Commission Expires March 2, 2026

*M. Bent*  
M. Bent Notary Public

**CERTIFICATE**

I, D. Johnson, Assistant Secretary of The Continental Insurance Company, a Pennsylvania insurance company, do hereby certify that the Power of Attorney herein above set forth is still in force, and further certify that the By-Law and Resolution of the Board of Directors of the insurance company printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said insurance company this 13th day of March 2023



The Continental Insurance Company

*D. Johnson*  
D. Johnson Assistant Secretary

Form F6850-4/2012

Go to [www.cnasurety.com](http://www.cnasurety.com) > Owner / Oblige Services > Validate Bond Coverage, if you want to verify bond authenticity.

## Authorizing By-Laws and Resolutions

ADOPTED BY THE BOARD OF DIRECTORS OF THE CONTINENTAL INSURANCE COMPANY:

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the Board of Directors of the Company at a meeting held on May 10, 1995.

“RESOLVED: That any Group Vice President may authorize an officer to sign specific documents, agreements and instruments on behalf of the Company provided that the name of such authorized officer and a description of the documents, agreements or instruments that such officer may sign will be provided in writing by the Group Vice President to the Secretary of the Company prior to such execution becoming effective.

This Power of Attorney is signed by Paul T. Bruflat, Vice President, who has been authorized pursuant to the above resolution to execution power of attorneys on behalf of The Continental Insurance Company.

This Power of Attorney is signed and sealed by facsimile under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 25<sup>th</sup> day of April, 2012.

“Whereas, the bylaws of the Company or specific resolution of the Board of Directors has authorized various officers (the “Authorized Officers”) to execute various policies, bonds, undertakings and other obligatory instruments of like nature; and

Whereas, from time to time, the signature of the Authorized Officers, in addition to being provided in original, hard copy format, may be provided via facsimile or otherwise in an electronic format (collectively, “Electronic Signatures”), Now therefore be it resolved: that the Electronic Signature of any Authorized Officer shall be valid and binding on the Company.”

# BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY

1314 Douglas Street, Suite 1400, Omaha, Nebraska 68102-1944

## ADMITTED ASSETS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Total invested assets	\$ 6,504,184,299	\$ 5,475,240,588	\$ 5,172,183,338
Premium & agent balances (n	552,510,359	603,615,506	368,086,012
All other assets	142,765,038	157,897,676	127,524,677
<b>Admitted Assets</b>	<u>\$ 7,199,459,696</u>	<u>\$ 6,236,753,770</u>	<u>\$ 5,667,794,027</u>

## LIABILITIES & SURPLUS \*

	<u>12/31/2021</u>	<u>12/31/2020</u>	<u>12/31/2019</u>
Loss & loss exp. unpaid	\$ 1,142,116,028	\$ 921,923,948	\$ 634,745,558
Unearned premiums	484,660,143	372,836,160	314,117,549
All other liabilities	1,163,007,684	1,054,922,210	744,738,458
<b>Total Liabilities</b>	<u>2,789,783,855</u>	<u>2,349,682,318</u>	<u>1,693,601,565</u>
<b>Total Policyholders' Surplus</b>	<u>4,409,675,842</u>	<u>3,887,071,452</u>	<u>3,974,192,463</u>
<b>Total Liabilities &amp; Surplus</b>	<u>\$ 7,199,459,697</u>	<u>\$ 6,236,753,770</u>	<u>\$ 5,667,794,028</u>

\* Assets, liabilities and surplus are presented on a Statutory Accounting Basis as promulgated by the NAIC and/or the laws of the company's domiciliary state.



### Power Of Attorney

#### BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY NATIONAL INDEMNITY COMPANY / NATIONAL LIABILITY & FIRE INSURANCE COMPANY

Know all men by these presents, that **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at One Lincoln Street, 23rd Floor, Boston, Massachusetts 02111, **NATIONAL INDEMNITY COMPANY**, a corporation existing under and by virtue of the laws of the State of Nebraska and having an office at 3024 Harney Street, Omaha, Nebraska 68131 and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, a corporation existing under and by virtue of the laws of the State of Connecticut and having an office at 100 First Stamford Place, Stamford, Connecticut 06902 (hereinafter collectively the "Companies"), pursuant to and by the authority granted as set forth herein, do hereby name, constitute and appoint: **Lisa M. Scavetta, Sherryanne M. DePirro, Maria L. Spadaccini, Nicholas F. Walsh, James Baldassare, Jr., Krista A. Burke, Charo J. Rosemond, John F. Surano, Bianca L. Meli, Michael Dugan, 250 Pehle Avenue, Suite 311 of the city of Saddle Brook, State of New Jersey**, their true and lawful attorney(s)-in-fact to make, execute, seal, acknowledge, and deliver, for and on their behalf as surety and as their act and deed, any and all undertakings, bonds, or other such writings obligatory in the nature thereof, in pursuance of these presents, the execution of which shall be as binding upon the Companies as if it has been duly signed and executed by their regularly elected officers in their own proper persons. **This authority for the Attorney-in-Fact shall be limited to the execution of the attached bond(s) or other such writings obligatory in the nature thereof.**

In witness whereof, this Power of Attorney has been subscribed by an authorized officer of the Companies, and the corporate seals of the Companies have been affixed hereto this date of December 20, 2018. This Power of Attorney is made and executed pursuant to and by authority of the Bylaws, Resolutions of the Board of Directors, and other Authorizations of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, which are in full force and effect, each reading as appears on the back page of this Power of Attorney, respectively. **The following signature by an authorized officer of the Company may be a facsimile, which shall be deemed the equivalent of and constitute the written signature of such officer of the Company for all purposes regarding this Power of Attorney, including satisfaction of any signature requirements on any and all undertakings, bonds, or other such writings obligatory in the nature thereof, to which this Power of Attorney applies.**

**BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Executive Vice President

**NATIONAL INDEMNITY COMPANY,  
NATIONAL LIABILITY & FIRE INSURANCE COMPANY,**

By: \_\_\_\_\_  
David Fields, Vice President

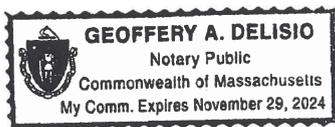


**NOTARY**

State of Massachusetts, County of Suffolk, ss:

On this 20th day of December, 2018, before me appeared David Fields, Executive Vice President of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY** and Vice President of **NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, who being duly sworn, says that his capacity is as designated above for such Companies; that he knows the corporate seals of the Companies; that the seals affixed to the foregoing instrument are such corporate seals; that they were affixed by order of the board of directors or other governing body of said Companies pursuant to its Bylaws, Resolutions and other Authorizations, and that he signed said instrument in that capacity of said Companies.

[Notary Seal]



Notary Public

I, Ralph Tortorella, the undersigned, Officer of **BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY, NATIONAL INDEMNITY COMPANY** and **NATIONAL LIABILITY & FIRE INSURANCE COMPANY**, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies which is in full force and effect and has not been revoked. IN TESTIMONY WHEREOF, see hereunto affixed the seals of said Companies this March 13, 2023.



Officer

To verify the authenticity of this Power of Attorney please contact us at: BHSI Surety Department, Berkshire Hathaway Specialty Insurance Company, One Lincoln Street, 23rd Floor Boston, MA 02111 | (770) 625-2516 or by email at [jennifer.porter@bhsispecialty.com](mailto:jennifer.porter@bhsispecialty.com) THIS POWER OF ATTORNEY IS VOID IF ALTERED  
To notify us of a claim please contact us on our 24-hour toll free number at (855) 453-9675, via email at [claims@bhsispecialty.com](mailto:claims@bhsispecialty.com), via fax to (617) 507-8259, or via mail.

**BERKSHIRE HATHAWAY SPECIALTY INSURANCE COMPANY (BYLAWS)**

ARTICLE V.

CORPORATE ACTIONS

....

EXECUTION OF DOCUMENTS:

....

Section 6.(b) The President, any Vice President or the Secretary, shall have the power and authority:

- (1) To appoint Attorneys-in-fact, and to authorize them to execute on behalf of the Company bonds and other undertakings, and
- (2) To remove at any time any such Attorney-in-fact and revoke the authority given him.

**NATIONAL INDEMNITY COMPANY (BY-LAWS)**

Section 4. Officers, Agents, and Employees:

A. The officers shall be a President, one or more Vice Presidents, a Secretary, one or more Assistant Secretaries, a Treasurer, and one or more Assistant Treasurers none of whom shall be required to be shareholders or Directors and each of whom shall be elected annually by the Board of Directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the Board of Directors, and shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the Board of Directors; and the Board of Directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the corporation.

**NATIONAL INDEMNITY COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BY-LAWS)**

ARTICLE IV

Officers

Section 1. Officers, Agents and Employees:

A. The officers shall be a president, one or more vice presidents, one or more assistant vice presidents, a secretary, one or more assistant secretaries, a treasurer, and one or more assistant treasurers, none of whom shall be required to be shareholders or directors, and each of whom shall be elected annually by the board of directors at each annual meeting to serve a term of office of one year or until a successor has been elected and qualified, may serve successive terms of office, may be removed from office at any time for or without cause by a vote of a majority of the board of directors. The president and secretary shall be different individuals. Election or appointment of an officer or agent shall not create contract rights. The officers of the Corporation shall have such powers and rights and be charged with such duties and obligations as usually are vested in and pertain to such office or as may be directed from time to time by the board of directors; and the board of directors or the officers may from time to time appoint, discharge, engage, or remove such agents and employees as may be appropriate, convenient, or necessary to the affairs and business of the Corporation.

**NATIONAL LIABILITY & FIRE INSURANCE COMPANY (BOARD RESOLUTION ADOPTED AUGUST 6, 2014)**

RESOLVED, That the President, any Vice President or the Secretary, shall have the power and authority to (1) appoint Attorneys-in-fact, and to authorize them to execute on behalf of this Company bonds and other undertakings and (2) remove at any time any such Attorney-in-fact and revoke the authority given.



# PROJECT MANUAL

TAXIWAY DS EAST

CONTRACT NO. 201737642-02

## VOLUME I

GENERAL REQUIREMENTS

ISSUED FOR CONSTRUCTION

MARCH 6, 2023

CITY & COUNTY OF DENVER

DEPARTMENT OF AVIATION

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**VOLUME I – GENERAL REQUIREMENTS****DIVISION 01 – GENERAL REQUIREMENTS**

<b>SPEC</b>	<b>DESCRIPTION</b>
011100	Summary of Work
011400	Work Sequence and Constraints
011430	Vehicle and Equipment Permitting
011810	Utilities Interface
012300	Alternates
012510	Substitutions
012910	Schedule of Values
013100	Project Management and Coordination
013119	Project Meetings
013210	Schedule
013223.11	Construction Layout and As-Built Surveys
013223.15	Survey Information
013223.19	Quantity Surveys
013233	Photographic Documentation
013300	Submittal Procedures
013325	Shop and Working Drawings, Product Data, and Samples
013510	Construction Safety
013516	Alteration Project Procedures
014100	Regulatory Requirements
014210	Referenced Material
014220	Abbreviations and Symbols
014225	Reference Standards
014230	Definitions and Conventions
014320	DEN Quality Assurance for FAA Funded Projects
014520	Contractor Quality Control Program – FAA
014525	Material Testing Agency
014545	Special Inspection Agency and Owner Testing Agencies
015050	Mobilization
015210	Temporary Facilities
015215	Field Offices
015525	Traffic Control
015719	Temporary Environmental Controls
015810	Temporary Signs
016000	Product Requirements

016610	Storage and Protection
017330	Cutting and Patching
017419	Construction Waste Management and Disposal
017420	Cleaning
017515	System Startup, Testing, and Training
017720	Contract Closeout
017825	Operation and Maintenance Data
017835	Warranties and Bonds
017840	Contract Record Documents
017900	Demonstration and Training
019113	General Commissioning Requirements

**END OF SECTION**

**SECTION 011100**  
**SUMMARY OF WORK**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY AND DESCRIPTION**

- A. The Work specified in this contract consists of furnishing all management, supervision, labor, materials, tools, equipment, services, testing and incidentals for the construction of the Work indicated in the contract documents including lump sum items and unit price items.
- B. The Work in this Contract may affect operations at DEN. The Contractor shall bid, plan and execute the Work to minimize disruption of operations and inconvenience to the public.
- C. Change Notice:
1. The Contractor will be required to submit a proposal for each Change Notice
  2. The Contractor shall submit a proposal for the complete scope of the Work within the specified duration identified by the Notice. Where there is no time requirement identified by the notice documents, the Contractor shall submit a proposal within 20 days of receiving the notice or as allowed in Title 11 - Changes in the Work, Contract Price, or Contract Time of the General Contract Conditions, 2011 Edition.
  3. The proposal could contain both competitive bid and estimated costs and shall adhere to the requirements of Title 11 of the General Contract Conditions.
  4. The Contractor shall not proceed on any change notice work until a change order is issued.
- D. Change Directives:
1. The DEN Project Manager may issue Change Directive(s) for a Scope of Work. The Contractor shall keep all Time and Material record for any Change Directive(s) issued until a final settlement for the task is settled and finalized in a Change Order.
  2. The Contractor shall keep records and approvals for all Time and Material impacts of a Change Directive until a final settlement is reached and fully executed by the DEN Project Manager.
  3. The Contractor may invoice for a Change Directive in accordance with Title 11 of the General Contract Conditions, 2011 Edition.
- E. Guaranteed Maximum Price (GMP): For Contracts assigned as GMP the Contractor shall follow the Special Conditions issued for the Contract.
- F. This Project will be administered using the current Project Management Information System (PMIS). The application will be supplied by DEN at no cost to the Contractor. DEN will provide PMIS training for up to two (2) of the contractor's personnel.
- G. The Contractor shall participate in a preconstruction coordination meeting and update the

existing BIM Project Execution Plan or prepare a BIM Project Execution Plan if one does not exist based upon the DEN BIM Project Execution Plan (BPXP) template included as provided by the DEN Digital Facilities and Infrastructure (DFI) group and the coordination meeting instructions.

- H. DEN utilizes several programs as part of the Asset Management System. Keeping accurate as-built record and operation and maintenance data are essential in the integrity and the validity of the airport operation. The Contractor is required to make every effort to keep the airport data informed, updated and accurate in the format required by DEN Project Manager:
1. The Contractor shall provide and implement BIM Project Execution Plan based on the DEN BIM Project Execution Plan. The Contractor shall employ or contract a consultant to provide all the requirements to produce the Project model in the latest edition of AutoCAD Civil 3D. The model shall be submitted to DEN in electronic format.
  2. The Contractor shall comply with all the requirements of DEN BIM Project Execution Plan and provide the data to DEN to produce the complete record of the BIM model of the Project
- I. Inspection Requirements:
1. Special Inspection and Testing required by the building official or the Engineer of Record in the Contract Documents or in the Statement of Special Inspections will be performed by DEN contracted Agencies.
  2. Contractor shall subcontract Qualified Material Testing Agency(s) to perform all necessary Quality Control, processing control and any additional Testing required by the Contract Documents.
  3. DEN Quality Assurance Manager may audit all material tests performed by the Contractor Quality Control at any time. Testing and Inspections for structural elements (reinforced concrete, steel, masonry caissons, fire protection, precast and post tension concrete) not identified as special inspection will be performed by the Contractor Quality Control Program and Contractor Material Testing Agency and audited and confirmed by DEN Quality Assurance Manager. DEN will perform 100% visual inspection on all weldments. DEN will perform Quality Assurance testing at a frequency of approximately 10% of the Quality Control test and inspection frequencies. The testing frequencies by DEN may escalate to higher percentages and the Contractor will be responsible for all costs associated with failing tests of the same pay item elements. The Contractor may not hire the DEN contracted or testing agency in any capacity on this Project.
- J. DEN Quality Assurance will perform all quality assurance pull and adhesion tests on all airfield joint sealants. Contractor shall perform all quality control tests for the same items.
- K. DEN Quality Assurance is required to submit a letter indicating that all Work performed on the project complies with all applicable codes. The Contractor shall make sure that all required test frequencies and all deficiencies has been corrected to comply with all applicable codes and standards and the requirements of the Contract Documents.

### **1.03 WORK BY OTHERS AND FUTURE WORK**

- A. Refer to Title 7 – Cooperation, Coordination and Rate of Progress of the General Contract Conditions, 2011 Edition.

### **1.04 SITE CONDITIONS**

- A. Refer to Title 14 – Site Conditions of the General Contract Conditions, 2011 Edition.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 CONTRACTOR'S DUTIES**

- A. Refer to Title 3 – Contractor Performance and Services of the General Contract Conditions, 2011 Edition.
- B. Execute the Work as specified and in a timely manner. Submit a schedule of Work that will be performed at times other than during the eight-hour working day of Monday through Friday, daylight hours. Submit this schedule five (5) working days prior to the beginning of Work to the DEN Project Manager for review and acceptance. Approval to work at night may be obtained after Contractor presents a written program outlining special precautions to be taken to control the extraordinary hazards presented by night work. That program shall include, but not be limited to, supplementary lighting of work areas, availability of medical facilities, security precautions, and noise limitations.

### **3.02 COORDINATION**

- A. Coordinate execution of the Work with those public utilities, governmental bodies, private utilities and other contractors performing work on and adjacent to the worksites. Eliminate or minimize delays in the Work and conflicts with those utilities, bodies, and contractors. Schedule governmental, private utility and public utility work that relies upon survey points, lines and grades established by the Contractor to occur immediately after those points, lines and grades have been established. Confirm coordination measures for each individual case with the DEN Project Manager in writing.
- B. In the coordination effort of work by others, the Contractor shall obtain and refer to equipment locations and other layouts, as available, to avoid interface problems.
- C. The City reserves the right to permit access to the site of the Work for the performance of work by other contractors and persons at such times that the City deems proper. The exercise of such reserved right shall in no way or to any extent relieve the Contractor from liability for loss and damage to the Work due to or resulting from its operations or from responsibility for complete execution of the Contract. The Contractor shall cooperate with other contractors and persons in all matters requiring common effort.

### **3.03 CONTRACTOR USE OF WORK SITE**

- A. Confine work site operations to areas permitted by law, ordinances, permits, and the Contract.
- B. Consider the safety of the Work and that of the people and property on and adjacent to the work site when determining amount, location, movement, and use of materials and equipment on work site.
- C. Do not load work site with equipment and products that would interfere with the Work. Only equipment, tools, or materials required for this Work may be stored at the work site.
- D. Protect products, equipment, and materials stored on work site.

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- E. Relocate stored products, equipment, and materials that interfere with operations of City, government bodies, public, and private utilities, and other contractors.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011100**

**SECTION 011400****WORK SEQUENCE AND CONSTRAINTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 OTHER WORK**

- A. Other concurrent construction contracts with which the Contractor must interface are described elsewhere in the Contract Documents. Refer to Section 013210 "Schedule" and the Special Conditions for specific work constraints and milestones.

**1.03 WORK SEQUENCE**

- A. The work sequence shall comply with Phasing, Sequencing, and Milestones as indicated in the Contract Documents and in accordance with the approved Construction Schedule developed by the Contractor. The schedule shall comply with requirements indicated in the Special Conditions and Section 011400 "Work Sequence and Constraints". The Construction Schedule is described in Section 013210 "Schedule".

**1.04 WORK CONSTRAINTS**

- A. Site Constraints:
1. Access to the Project shall be generally as indicated in the Contract Documents. Access shall be organized and planned by the Contractor to ensure no disruption of airline or DEN operations.
  2. Access to work sites will be strictly monitored and must comply with DEN Airport Operations and FAA Regulations. The Contractor shall provide monitoring and escorts as required by DEN Operations in the area of the Work.
  3. The Contractor's staging area will be as indicated in the Construction Documents.
  4. Contractor employee parking will not be allowed within the existing revenue control system. Parking facilities will be as indicated in the Construction Documents.
  5. The Contractor shall use the haul routes specified in the Construction Documents.
  6. If required, the Contractor shall provide a bus and driver to transport the Contractor's employees between the designated employee parking area and the work sites. No separate payment will be made for this bus and driver. The cost shall be included in the bid item "Mobilization". The bus driver shall be provided at all times when Contractor employees are working on the Project.
- B. System Interruptions:
1. DEN is a 24/7/365 facility. Construction activity that requires any system shutdown must be coordinated with the project manager and DEN AIM MCC.
  2. The Shutdown cannot proceed unless all approver groups have approved the request. If any of the groups rejects the request, you may not proceed with the Shutdown. If a Shutdown is determined to be an emergency due to pending health issues or the risk of additional damage, this process may be bypassed. If the Shutdown is an

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 011400 – WORK SEQUENCE AND CONSTRAINTS**

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emergency, proceed with the shutdown without the approvals. Approvals must be obtained as follows

- a. Airfield Shutdowns must be submitted at least 72 hours prior to the shutdown start date.
- b. All other Shutdowns must be submitted at least five (5) business days prior to the shutdown start date.
- c. All Shutdown Requests must be submitted using the Shutdown Request form, which can be accessed via the Home page of the DEN intranet.

**C. Airfield Operations at Denver International Airport:**

1. Full airport and aircraft operations are underway adjacent to this Project. Contractors are required to obtain a Contractor Participant Manual from the Security Manager and must follow the guidelines in the manual. Copies of the Contractor section of the manual are available for review at the Denver International Airport Access Services Office.
  - a. If any Work contains requirements for Work activities or access through or in the restricted area, reference Section 011420 "Security Requirements & Sensitive Security Information (SSI)" for requirements.
  - b. If not in a restricted area, the Contractor personnel still must be badged; reference Section 011420 "Security Requirements & Sensitive Security Information (SSI)".

**D. Conduct of persons using the Denver Municipal Airport system:**

1. Contractor activities shall comply with Airport Operations and Regulation 130 "TRAFFIC" and Regulation 20 "CONDUCT OF PERSONS USING THE DENVER MUNICIPAL AIRPORT SYSTEM" shall be followed at all times. These regulations are available from Airport Operations at Denver International Airport.

**E. Operational safety on airports during construction:**

1. All Work shall be accomplished in accordance with FAA Advisory Circular AC150/5370-2 (current edition), "Operational Safety on Airports during Construction", FAR Part 139 and FAR Part 107 except as herein modified.

**F. Welding Equipment, Procedures and Constraints:**

1. Natural gas-powered portable welders or inverter single- and three-phase electric portable welders are the only acceptable welding equipment to be used inside the building basement or tunnel areas. Acceptability of equipment other than the equipment noted above shall be at the sole discretion of the DEN Project Manager.
2. Welding activities inside buildings require submittal of a System Interruption Request (See paragraph "System Interruptions" above). Prior to welding in any area, the Contractor shall locate smoke detectors and shall request interruption of the fire alarm system. Subsequent to the interruption of the fire alarm system and prior to welding activities, the Contractor shall cover and protect smoke detectors until work is complete. Prior to expiration of each interruption of the system, the Contractor shall uncover the smoke detectors.
3. Electrical Service: The Contractor shall be responsible for verifying with the DEN Project Manager or representatives locations acceptable for accessing electrical power for welders and other electrical equipment feeders. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.
  - a. Temporary Hook-up: In addition to the requirements of paragraph "Temporary Power and Lighting for Construction" below, comply with the following:

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**TECHNICAL SPECIFICATIONS**  
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**SECTION 011400 – WORK SEQUENCE AND CONSTRAINTS**

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- 1) Provide wiring sized to accommodate full load of welding equipment, accounting for voltage drop.
  - 2) Provide appropriate NEMA twist-lock or ANSI receptacle for welder hook-up.
  - 3) 480V, 3 phase, 3 pole, 4-wire twist lock ground line.
  - 4) NEMA L16-20 or ANSI C73.87.
- b. The Contractor may not begin operation of the equipment prior to request for inspection by DEN representatives and acceptance of the installation.
  - c. Permanent installation of electrical branch circuiting for welding equipment shall be made in accordance with all Division 26 Specification Sections
4. Welding Practices: All standard safe welding practices must be followed, including but not limited to the following:
- a. Flash protection for surrounding areas.
  - b. Contractor fire extinguisher in area.
  - c. One person in each welding area solely designated as fire watch for each welder.
  - d. Protect all equipment, cable trays and contents, etc., in area.
  - e. Use fire blankets and other appropriate materials to confine sparks and molten metal from the welding, cutting, and/or grinding activities.
  - f. All welders shall have been qualified through welding tests in accordance with applicable welding code, such as but not limited to AWS, ASME, API, within one year prior to welding taking place. Evidence of qualification shall be through Welding Performance Qualification Records (WPQR).
  - g. All welder qualifications test shall be or shall have been administered and witnessed by an Independent Testing Agency (ITA), AWS Certified Welding Inspector (CWI).
  - h. If recertification of welders is required, delay costs and retesting costs shall be borne by the Contractor.
5. Grounding: Review with DEN representative's area of work prior to beginning work to ensure ground procedures do not induce undesirable charges in steel building system or other systems. This review should take place subsequent to the pre-work meeting. Do not ground to adjacent building systems, baggage system, hangers, or devices that support mechanical or electrical equipment.
- G. Temporary Power and Lighting for Construction:
1. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.
  2. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.
    - a. Comply with all requirements of NEC Article 590.
    - b. Flexible cords used for temporary power shall be listed in accordance with NEC Article 400, and rated for 'extra-hard' usage.
    - c. Provide an equipment grounding conductor with all temporary power circuits.
    - d. All temporary power distribution devices and equipment shall be listed and rated for the application.
    - e. Provide ground fault protection for personnel.
    - f. Temporary lighting fixtures shall be protected from physical damage.
- H. Cleaning Equipment and Spoils:
1. Discharge of water, liquids, or chemicals into a building sanitary sewer system or storm drainage systems is prohibited. The Contractor shall comply with all Federal, State, and Local requirements for disposal of chemicals and equipment wash water. The Contractor shall maintain and service all equipment in work areas and collect all

wash water, spoils and water from excavations in containers for discharge or removal off site.

- I. Vehicle Permitting for Tunnel and Basement Use:
  - 1. Electric carts require permitting. The Contractor shall provide at least one (1) electric cart for Contractor use during the work in the tunnel and basements of the buildings. Only electric or CNG powered trucks are allowed in the tunnel and basements of the buildings. Only electric or CNG trucks may be used and shall not be parked overnight or for long terms within the tunnel or basements. All vehicles require permitting. Permits may be acquired at the DEN Airport Security Office.
  
- J. Radio and Cell Phone Use:
  - 1. The Contractor shall have wireless communications in place prior to initiation of work in the tunnel or basements by use of cell phone and/or radio. Radio and cell phone coverage in the tunnels and basements varies in signal strength throughout the campus. An RF Application must be submitted for the Radio equipment intended for use at least 14 days prior to intended use. Include the following radio information:
    - a. Make
    - b. Model
    - c. Frequency
    - d. Effective Radiated Power (ERP)
  - 2. Contractors must receive an approval letter from the RF Systems Manager prior to use of the radio equipment on the DEN campus.
  
- K. Keys:
  - 1. The Contractor shall be required to contact DEN Maintenance Control to procure keys for access to all rooms having locks in order to gain access. Keys may be checked out at the beginning of each work shift by the Contractor and shall be returned to DEN Maintenance Control at the end of each work shift

## **1.05 COORDINATION**

- A. The Contractor will designate a contact person for coordination with the DEN Project Manager and airline tenants. The contact person shall have the authority to make decisions for the Contractor firm and shall have binding signatory power for changes in work. The contact person shall be on site at all times during work activity.
  
- B. No additional costs shall be considered for coordination activities throughout this project. The Contractor shall include in the Contractor's bid costs for coordination of all activities.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 DUST/PROTECTION BARRIERS**

- A. HVAC system containment. The Contractor shall submit to DEN Maintenance HVAC and Fire Alarm shutdown requests prior to modifications to the area of work for dust containment. The HVAC system shall be interrupted, re-routed, or blocked off to prevent dust from entering return or supply ducts.

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- B. Debris and Protection Barriers:. The Contractor shall construct code-approved and DEN-approved dust and debris barriers on both sides of walls and doors that are to be modified. Barriers shall be constructed to allow emergency ingress and egress to and from equipment and spaces. Barriers shall be constructed to allow continual uninterrupted function of building equipment and spaces.
1. Return all removed door hardware to DEN. Label each hardware set correlating the door number of the original hardware set. Coordinate with the DEN Project Manager for storage and return of hardware.

### **3.02 EQUIPMENT**

- A. Equipment: CNG-powered equipment is allowed within the buildings. No other fossil fuel equipment may be used within the buildings unless the equipment is directly vented to the building exterior.
- B. Electric: Electric powered equipment is acceptable in the Work area.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011400**

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**SECTION 011430****VEHICLE AND EQUIPMENT PERMITTING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Contractor shall comply with the Airport Security Program. Vehicle permits are required for all vehicles operating in the Secured Area. The DEN vehicle permit is required even if the vehicles are operating in the Secured Area but limited to above grade, outdoor activity. Vehicles or machinery operating within buildings shall be required to acquire a DEN emissions permit as well as a DEN vehicle permit.
- B. Special emphasis should be paid to Denver Municipal Airport System Rules and Regulations Part 20 – Airport Security Rules and Regulations and Part 130 – Operating Vehicles In The Secured Area" and Part 35 – Operations Infraction Accountability Program". The Denver Municipal Airport System Rules and Regulations can be found on the flydenver.com website.
1. All Work shall be accomplished in accordance with the most current version of FAA Advisory Circular (AC) 150/5370, "Operational Safety on Airports during Construction", 49 Code of Federal Regulations (CFR) Part 1542 and 14 CFR Part 139 except as modified herein.
  2. All Work shall be accomplished in accordance with the most current TSA Security Directives applicable to DEN, except as modified herein.
  3. Contractor may access runways, taxiways, and aprons only as necessary and only after establishing radio communications with Airport Operations through the DEN Inspector. No personnel or equipment will be allowed on the runways until radio contact has been made with Airport Operations and permission given.
  4. Access to the Movement Area will be limited in order to allow the maximum efficient movement of aircraft. As part of this limitation, the Contractor may be required to only use these areas late at night when there is less aircraft traffic
  5. Once admitted into the Secured Area, the Contractor shall proceed directly to the work location by way of the approved haul route. At no time shall a Contractor or any of its personnel enter onto a taxiway, runway, or ramp without proper clearance from the Airport Operations Manager or Assistant Airport Operations Manager. Contractors or individuals violating these requirements for driving in the Secured Area may be subject to fines, suspension, or permanent revocation of their driver authorization and/or Airport ID badge privileges.
  6. The Transportation Security Administration (TSA) requires that all operating airports be secured from the general public and has the authority to issue citations for violations of these requirements. It is the responsibility of the Airport to ensure all fences and gates are secure. If a Contractor's operations necessitate the frequent use of a particular gate, the Contractor shall place guards at the gate. Refer to 011420 – Security Requirements and SSI for details regarding the placement of guards.
- C. General Safety Regulations When in Aircraft Operations Areas May Include the Following:

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1. At all times, the Contractor shall coordinate its Work with the requirements of the Airport site and operations. All Work, movement of personnel, materials, supplies and equipment in areas used by aircraft shall be subject to regulations and restrictions established by the City. The Contractor shall take special precautions and be fully responsible for the prevention of damage to materials and equipment in the areas affected by the jet blast of taxiing aircraft. No work shall proceed until necessary protective devices are placed as required to protect the public, airport operations, property, and personnel from the hazards of the Work. The Contractor shall proceed with the Contractor's Work, including temporary work and storage of tools, machinery, and materials, to cause no interference with or hazards to the operation of the Airport.
  2. Landings, takeoffs, and taxiing shall take precedence over all Contractors' operations. In the event that the Contractor is notified that an emergency landing or a takeoff is imminent, the Contractor shall stop all operations immediately, regardless of the sequence of events in progress and shall immediately evacuate the Contractor's personnel and equipment from the runway and taxiway areas as directed.
  3. The Contractor shall remove its personnel and equipment to the distance specified below for the prevailing conditions:
    - a. For emergencies, the Contractor shall move all personnel and equipment as directed by Airport Operations or the DEN Project Manager.
    - b. At the end of a work day in areas where aircraft are operating, all equipment shall be moved to a location that is not less than 750 lineal feet measured from the near edge of the runway, taxiway or ramp area or to the location designated by the City.
  4. If the Contractor is asked to leave part of its work site to allow aircraft operation, the Contractor shall clean the area to allow safe aircraft movement. Cleaning may include sweeping the area to prevent damage to aircraft.
- D. Vehicle Permitting:
1. Refer to the Denver Municipal Airport System Rules and Regulations Part 20 – Airport Security Rules and Regulations and Part 130 – Operating Vehicles In The Secured Area" and Part 35 – Operations Infraction Accountability Program" for information regarding vehicle permitting. These Denver Municipal Airport System Rules and Regulations can be found on the flydenver.com website.
  2. Contractor should contact DEN Project Manager to submit Airfield Access requests for all vehicles and equipment not previously permitted. This includes vehicles and equipment for subcontractors. For additional information regarding permitting, the Contractor must contact DEN Security.
- E. Equipment Permitting
1. Fossil fuel powered equipment to be used in the interior of buildings and/or in basement/tunnel areas shall require inspection by DEN Maintenance and the Denver Fire Department.
    - a. Only CNG fossil fuel powered equipment may be used; gasoline powered, propane powered, or diesel-powered equipment will not be acceptable unless identified and operated per Section 011400 "Work Sequence and Constraints".

### **1.03 SUBMITTALS**

- A. Refer to Section 03300 "Submittal Procedures" for submittal procedures
- B. Submit a copy of each vehicle permit and/or equipment and vehicle emissions permit a maximum of fourteen (14) days after receipt of permit.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.01 PERMITS**

- A. Vehicle permits shall not be issued prior to Notice to Proceed. The Contractor may, at the Contractor's own risk, submit required information prior to Notice to Proceed to the following:
  - 1. Airfield Access request: DEN Project Manager.
  - 2. Vehicle permit: DEN Airport Security.
  - 3. Equipment and vehicle emissions permit. DEN Project Manager or DEN Maintenance Group.

**3.02 SCHEDULE**

- A. The Contractor shall allow in the Contractor's schedule five (5) days for DEN review of submittals for permits. Testing of equipment and review by the Denver Fire Department shall be scheduled by the Contractor. By submitting information for permits, the Contractor certifies that equipment and vehicles comply with Contract documents and with all City, state and federal regulations including but not limited to emissions, licensing and safety requirements.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011430**

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**SECTION 011810**  
**UTILITIES INTERFACE**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Various utilities are located within the limits of work in the Project area. The owners of these utilities may require that the Contractor work around their existing facilities until alterations, relocation, or abandonment have been completed. All known existing utilities are shown; however, the Contractor shall verify and satisfy itself that there are no other existing utilities that may not be shown.
- B. The owners of known utilities within the project area include, but are not limited to:
1. Xcel Energy Natural Gas
  2. Xcel Energy Elec. Services
  3. DEN Storm Water
  4. DEN Deicing Waste
  5. Denver Water Department
  6. FAA Duct Bank
  7. DEN Electrical Department
- C. The location and establishment of each construction vehicle crossing shall be at sites mutually agreed upon in writing by the Contractor and the owner of the utility.
- D. At the locations where the Contractor needs to establish a construction vehicle crossing over any of the operating pipelines, the furnishing and placing of a crossing shall be by the Contractor. The crossing shall allow the normal operation of the pipeline at all times unless specifically approved by DEN or the owner of the pipeline. Each crossing shall be adequately marked and signed for safe passage of vehicles over the crossing. Construction vehicles shall not be allowed to cross over operating pipelines at any place other than an established crossing.
- E. These utility locations are based upon information provided by the utility companies or previous construction contractors that were the basis for determining utility coordinates. The Contractor is responsible for confirming the accuracy of the provided coordinates with the utility owner.
- F. The Contractor shall control the Contractor's operations in order to avoid creating any obstacles for the utility owner's access for maintaining or operating their equipment.

**1.03 REFERENCE DOCUMENTS**

- A. Item P-153 "Controlled Low-Strength Material."

**1.04 REGULATORY REQUIREMENTS**

- A. The Contractor shall obtain and pay for all utility company permits, fees, and licenses necessary for the execution of this work. The Contractor shall give all notices and shall comply with all laws, ordinances, rules, and regulations of all authorities having jurisdiction.

**1.05 QUALITY CONTROL**

- A. When the Contractor performs any operations that will affect a utility owner, the Contractor shall give timely notice to the utility owner and the DEN Project Manager so that the Contractor's operations may be observed by the utility owner or their representative.

**1.06 WORK INCLUDED**

- A. The Work of this Section includes furnishing all materials, equipment, and labor necessary to provide utility crossings as required and as specified herein and subject to approval by the associated utility owner.
- B. North American Resources has a line passing through airport property. The Contractor shall contact the utility prior to beginning earthwork operations to ascertain any special requirements or conditions required to maintain and protect this service during construction activities.
- C. FAA Underground Duct lines: The FAA has duct lines passing under the site. The Contractor shall contact the FAA prior to beginning earthwork operations to ascertain any special requirements or conditions required to maintain this service during construction activities.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Suitable cover material shall be in accordance with Colorado Department of Transportation Standard Specifications. Wet, soft, or frozen material, asphalt chunks, or other deleterious substances shall not be used for cover.
- B. Aggregate for road base material shall consist of clean, sound and durable particles of crushed stone, crushed gravel or crushed slag, shall be free from coatings of clay, silt and organic matter, and shall contain no clay balls. Material shall conform to the State of Colorado Standard Specifications for Road and Bridge Construction Class 6 aggregate base unless otherwise specified.
- C. The materials for the load distribution system on top of the cover shall conform to the specification of the American Institute of Steel Construction, the American Institute of Timber Construction, or the American Concrete Institute, as applicable, depending upon the system agreed upon between the Contractor and utility owner.
- D. Materials for the sleeving of the pipelines shall be purchased by the utility owner at the Contractor's expense.
- E. Comply with utility backfill requirements for the use of flowable backfill in Item P-153 "Controlled Low-Strength Material".

**PART 3 - EXECUTION**

**3.01 NOTIFICATION OF UTILITIES FOR LOCATING AND POTHOLING**

- A. The Contractor shall verify the location of all utilities prior to any operations including physically uncovering the utility to verify location as required by the utility owner.
- B. The Contractor shall notify the Utility Notification Center of Colorado at (303) 534-6700 or 811, as a minimum for location of utilities.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 011810**

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SECTION 011810 – UTILITIES INTERFACE**

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**SECTION 012300****ALTERNATES****PART 1 - GENERALP****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for alternates.

**1.03 DEFINITIONS**

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
  2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

**1.04 PROCEDURES**

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Prior to the Contractor signing the Contract, the Owner will notify each party involved, in writing, of the status of each alternate, indicating if alternates have been accepted, rejected, or deferred for later consideration. The owner will also include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other Work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the Work described under each alternate.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 SCHEDULE OF ALTERNATES**

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A. This contract does not include alternates. .

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 012300**

**SECTION 012510****SUBSTITUTIONS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. All material and equipment substitutions must comply with Title 4, Article 406: Substitution of Materials and Equipment in the General Contract Conditions, 2011 Edition.
- B. The Work specified in this Section consists of submitting form CM-09, Request for Substitution for the approval of a different material, equipment, or process than is described in the Contract Documents.
- C. If the substitution changes to the Scope of Work, Maximum Contract Cost, cost of the Work (if less than the Maximum Contract Cost), or Contract time, a Change Order is required.
- D. As-built drawings and specifications must include all substitutions even if a Change Order is not issued.

**1.03 REFERENCE DOCUMENTS**

- A. Form CM-09, Request for Substitution
- B. Section 013300 "Submittal Procedures"
- C. Section 013325 "Shop and Working Drawings, Product Data and Samples"

**1.04 QUALITY CONTROL**

- A. The substitution shall provide as a minimum, the same performance as specified.

**1.05 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. A completed Form CM-09 shall be submitted at least 60 days prior to when an order needs to be placed or a method needs to be changed.
- C. The submittal shall contain all the data required to be submitted for acceptance of the originally specified item or process, including, as appropriate:
  - 1. Detailed product data sheets for the specified items and the substitution.
  - 2. Samples and shop drawings of the substitution.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION****3.01 SUBSTITUTION PROCESS**

- A. Provide the information as required on Form CM-09.

**3.02 SUBSTITUTION REQUEST**

- A. The formal Request for Substitution will be evaluated by the DEN Project Manager and the Designer of Record based on the following criteria:
1. Compatibility with the rest of the project.
  2. Reliability, ease of use and maintenance.
  3. Both initial and long term cost.
  4. Schedule impact.
  5. The willingness of the Contractor to share equally in any cost savings.
  6. The ability of the item or process to meet all applicable governing regulations, rules, and laws along with funding agency requirements.
  7. The cost of evaluating the substitution.
- B. Based upon the above evaluation, the Senior Director of AIM Development will make a final determination of what is in the best interest of the City and either approve, disapprove or approve as noted the requested substitution.

**3.03 CONDITIONS**

- A. As a condition for submitting a Request for Substitution, the Contractor waives all rights to claim for extra costs or changes in the costs, schedule, Contract time or Scope of Work, other than those outlined in the request and approved by the Senior Director of AIM Development. The Contractor, by submitting a Request for Substitution, also accepts all liability for cost and scheduling impact on other contractors or the City due to the substitution.
- B. Included with the Request for Substitution shall be the following statement:
1. "The substitution being submitted is equal to or superior in all respects to the Contract-required item or process. All differences between the substitution and the Contract-required item or process are described in this request along with all required information, cost, and scheduling data."
- C. The statement shall be signed and dated by the Contractor's Superintendent.
- D. Replacement of Substitution Found to be Not Equal: The Contractor shall be responsible for all aspects and conditions of the substitution that are not clearly identified in the substitution submittal, and shall be liable for the appearance, function, performance or other aspects of the substitution that are found not to be equal to the originally specified item.
1. The Contractor shall incur all labor and costs associated with replacement of any substitution that is found to be not equal to the originally specified item or process and rejected by the DEN Project Manager.
  2. The replacement of any rejected substitution shall either be with the originally specified item or process, or a substitution approved by the DEN Project Manager.

**PART 4 - MEASUREMENT**

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**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 012510**

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**SECTION 012910**  
**SCHEDULE OF VALUES**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions other Division 01 Specification Sections, and Related Requirements apply to this Section.

**1.02 RELATED REQUIREMENTS**

- A. The Work specified in this Section consists of preparing and submitting the Schedule of Values ("Schedule") as referenced in the General Conditions. Use the Project Specifications Table of Contents or Schedule of Prices and Quantities (Bid Tabs), if applicable, as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section. The Work also includes the preparing and submitting of updated copies of the Schedule if the Schedule is affected by change orders.
- B. A Schedule of Stored Material is a detailed cost breakdown for permanent materials that will be temporarily stored prior to their being installed and for which the Contractor seeks partial payments. The Schedule of Stored Material will be incorporated as a part of the Schedule of Values.
- C. Within 14 calendar days of issuance of the Notice to Proceed (NTP), the Contractor shall submit the Schedule of Values including the Schedule of Stored Material if applicable. The Schedule of Values and Schedule of Stored Material used to prepare the work/cost breakdown for the Schedule will be used for the Contractor's billings.
- D. D.Any Contract allowances shall be included in the Schedule. Expenditure of allowances shall be done using the Allowance Authorization form. Use of this form does not increase or decrease the Contract value.

**1.03 RELATED DOCUMENTS**

- A. Title 9 – Compensation of the General Contract Conditions, 2011 Edition
- B. Section 013300 "Submittal Procedures"
- C. Section 013325 "Shop and Working Drawings, Product Data and Samples".
- D. Form CM-89, Schedule of Values
- E. Form CM-91, Schedule of Values for Unit Price Contracts

**1.04 SUBMITTALS**

- A. The Schedule of Values shall be formally approved by the DEN Project Manager.
- B. The Schedule shall identify each item of work. Work items in the Schedule shall represent all Work and shall be referenced with the Technical Specifications section numbers, specification subparagraph, specification section title and the bid item number used for the Schedule of Prices and Quantities when applicable.

- C. Upon request by the City, the Contractor shall support values given with the data that will substantiate the correctness of the values.
- D. The Schedule will be utilized only as a basis for review of the Contractor's application for progress payment.

**1.05 REVIEW AND RESUBMITTAL**

- A. If review by the DEN Project Manager indicates that changes to the Schedule are required, the Contractor shall revise and resubmit the Schedule.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PREPARING SCHEDULE OF VALUES**

- A. Provide a breakdown of the Contract Price in enough detail to facilitate continued evaluation of Applications for Payment and progress reports.
- B. Breakdown of the items used in the Schedule shall include the following item costs. Ensure each item is complete:
  - 1. Delivered cost of product with applicable taxes paid.
  - 2. Total installation cost with overhead and profit.
  - 3. Breakdown costs of each lump sum item with a list of products and major operations for which the Contractor seeks to receive progress payments to recover the Contractor's costs for that bid item.
  - 4. Each unit price item as listed in the bid Schedule of Prices and Quantities shall list products and major operations for which the Contractor seeks to receive progress payments for that bid item.

**3.02 PREPARING SCHEDULE OF STORED MATERIAL**

- A. The Contractor shall submit with the Schedule an indication of whether products will be stored on or off the work site. The Schedule of Stored Material shall show all quantities and types of products that will be stored.
- B. Material allowances consist of only the net cost of the product, the cost of delivery and unloading at the storage site, the cost of applicable sales taxes, and all discounts.
- C. In no case will the cost paid for a permanent material be greater than 90 percent of the Contract price for the Work in which they are included.

**3.03 PAYMENT FOR STORED MATERIALS**

- A. Only materials that are described in the specifications and on the drawings will be considered permanent materials. Permanent materials are materials that will be left in the Work after the Contract is completed.
- B. Nothing in these specifications shall be interpreted as requiring the City to pay for stored materials. The DEN Project Manager shall decide on a case-by-case basis whether stored materials shall be paid for. No payment will be made for stored materials that have not been submitted and accepted.

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- C. The Contractor must, at all times, store permanent materials in accordance with manufacturer's recommendations. Any material not properly stored will not be paid for. Amounts will be deducted from payments for any stored permanent material previously paid for and subsequently found to be improperly stored or not present, based upon a physical inventory of stored permanent material.
- D. Only the neat line quantity of material needed for the finished product may be paid for.
- E. All requests for stored permanent material payment must be accompanied by paid invoices clearly showing the quantity of permanent material, the type of permanent material and discounts or rebates and the net amount paid to the supplier along with a certificate stating that the permanent material is free of any liens or judgments preventing its use by the City.
- F. If the permanent material is stored outside the Denver area the Contractor must pay for the City representative's transportation and lodging to see the stored material as needed. Acceptable lodgings must, as a minimum, have a Mobil Travel Guide Rating Criteria® rating of Two-Star or the American Automobile Association Lodging Listing Requirements & Diamond Rating Guidelines® rating of Two Diamonds. The minimum transportation shall be by regularly scheduled commercial air carrier at coach rates. The DEN Project Manager will determine if an overnight stay is required.
- G. All permanent material stored off site, for which payment is being requested, must be insured and stored in bonded, insured warehouses. The Contractor shall provide proof of insurance for all material stored off site, and specific address and storage conditions of storage location.
- H. Any permanent material on which payment is requested must be in such a form that it cannot be used on work other than this Contract, or stored in a manner acceptable to the DEN Project Manager to ensure that the permanent material cannot be used on work other than this Contract.

**3.04 ALLOWANCE AUTHORIZATION AND PAYMENT**

- A. Contractor shall request written approval for expenditure of any Contract allowances PRIOR TO performing the Work involved. List work to be performed and estimated cost in the requesting correspondence.
- B. Original copies of all invoices and receipts must be submitted with the Allowance Authorization as part of the request for payment.
- C. Using the format provided by the City, the Contractor's request for payment of all Contract allowances shall be included in the Schedule of Values.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

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- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 012910**

**SECTION 013100****PROJECT MANAGEMENT AND COORDINATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative provisions for coordinating construction operations and coordination with other stakeholders and adjacent Contractors on the Project including,
1. Subcontractor's Acceptance Certification and Subcontractors List.
  2. General Coordination Procedures.
  3. Contract Administration Procedures.
  4. Current Project Management Information Systems (PMIS)
  5. Coordination drawings.
  6. Current DEN Asset Management Systems
  7. Requests for Information (RFIs).
- B. Related Requirements:
1. Section 011100, " Summary of Work" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
  2. Section 011400 "Work Sequence and Constraints" for shutdown requests and coordinating with airport operational activities.
  3. Section 011420 "Security Requirements and Sensitive Security Information (SSI)".
  4. Section 013210 "Schedule" for preparing and submitting Contractor's Construction Schedule.
  5. Section 013223 "Construction Layout, As-built and Quantity Surveys" for coordinating, survey activities and survey related record documents.
  6. Section 013300 "Submittal Procedures. "
  7. Section 013325 "Shop and Working Drawings, Product Data and Samples".
  8. Section 017720 "Contract Closeout" for coordinating closeout of the Contract.
  9. Section 017419 "Construction Waste Management and Recycling".
  10. DEN Building Information Modeling (BIM) Design Standards Manual (DSM)

**1.03 DEFINITIONS**

- A. RFI: Request from the DEN Contractor DEN Project Manager seeking information required by or clarifications of the Contract Documents.

**1.04 SUBMITTALS - SUBCONTRACTORS ACCEPTANCE CERTIFICATION AND  
SUBCONTRACTORS LIST**

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- A. To comply with Section 502.2 in the General Contract Conditions, 2011 Edition, the Contractor must complete and submit form CM-02 Subcontractor Acceptance Certification for each Subcontractor working on the project. Additionally, the Contractor must prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.
- B. Provide emergency contacts list to the DEN Project Manager prior to any site activities. List must contain project name, number, location, company name and address, name and title of emergency contacts in order and time and assigned responsibilities. Keep list current and accurate at all times. Include any specific security arrangements or special projects requirements.
- C. Within two (2) days of Notice to Proceed, the Contractor shall submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identifying individuals and their duties and responsibilities listing addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Providing names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
  1. Post copies of the accepted list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

**1.05 GENERAL COORDINATION PROCEDURES**

- A. Coordination with other Contractors:
  1. For details on coordinating with other Contractors, refer to Article 701 Cooperation with Other Work Forces, Article 702 Coordination of the Work, and Article 703 Coordination of Public Contact in the General Contract Conditions, 2011 Edition.
- B. Minimum cooperation requirements with other contractors include the following, unless directed by the DEN Project Manager in writing:
  1. Regular meetings, minimum weekly.
  2. Construction schedule coordination.
  3. Staging area and access planning (to include employee shuttle routes).
  4. Deliveries.
  5. Traffic control.
  6. When and where required or specified, the Contractor shall develop appropriate coordination drawings for use by interfacing adjacent parties using the Denver International Airport site.
- C. The following is a list that includes, but is not limited to, all of the contractors that will be working in the area of the project limits: TBD at time of contract award.
- D. Coordination with DEN entities shall include but is not limited to the following:
  1. Coordinate with Owner Contracted Communication Contractor.
  2. Coordinate with Utility Companies for utilities that are single sole source.
  3. Coordinate with Airport Security and DEN Maintenance for all security related services.
  4. Coordinate with DEN Life Safety Team for all issues related to fire alarm, fire protection systems in addition to compliance with all regulatory agencies.
  5. Coordinate all shutdowns and system interruptions in accordance with section 011400

"Work Sequence and Constraints."

## **1.06 CONTRACT ADMINISTRATION PROCEDURES**

- A. This Project will be administered in part using the current Project Management Information System (PMIS). Any processes necessary to properly administer the Contract and not included in the list below shall be addressed as acceptable to the DEN Project Manager. DEN Project Manager may modify the list below in serialized correspondence without constituting a change to the Contract. Administrative tools and processes shall not in any form waive any contractual or legal requirements of the law or the Contract. The Contractor shall attend all coordination meetings with the DEN Project Manager and the DEN Project Control Administrators to arrange for staff training, and technical support to facilitate the execution of electronic data management and control.
- B. Project Management Information Systems (PMIS): Oracle Unifier Enterprise Project Portfolio Manager (EPPM), or the Oracle Primavera P6.
- C. All submittals, RFIs, Pay Applications, Correspondence, change requests, and pricing proposals and settlement agreements shall be recorded and submitted using the current PMIS:
  - 1. The Contractor shall follow the specified PMIS Access Request Procedure and adhere to all user license conditions.
  - 2. The Contractor shall sign the Information Technology Agreement (ITA) to comply with the DEN computer system security requirements and any contractual obligation to the software and service providers for the current PMIS software
  - 3. DEN will train the Contractor's staff on the use of the PMIS.
  - 4. At a minimum, the Contractor shall provide computer hardware and software to meet the following requirements and to run the following programs, as required for the project:
    - a. Internet connectivity that provides the necessary high-speed connection to perform all activities indicated in this Contract.
    - b. Internet Explorer version 8 or higher.
    - c. Based on the project, a specific Java JRE application may be required, which can be downloaded from the Internet. If needed, the revision and update number will be provided at NTP.
    - d. Other files capability pre-approved by the DEN Project Manager or as required by the DEN BIM Execution Plan
    - e. Most current version of Revit, as per DEN requirements.

## **1.07 COORDINATION DRAWINGS**

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, BIM Design Standards Manual and BIM Project Execution Plan (BPXP), and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity. Coordination drawings will be the result of a Contractor driven Spatial Coordination effort as spelled out in the BPXP.
  - 1. Field verify all existing dimensions and any as-built dimensions, whether built by the Contractor or others, necessary to produce accurate coordination and working drawings.
  - 2. Content: Project-specific information, drawn accurately to a scale large enough to

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indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

- a. Use applicable Models/Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
  - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
  - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
  - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
  - f. Indicate required installation sequences.
  - g. Indicate dimensions shown on the Models/Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to DEN Project Manager indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Using software as in the BPXP, the Contractor shall coordinate these systems per floor or zone per BPXP, and as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
  2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
  3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire alarm, and electrical equipment.
  4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
  5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
  6. Mechanical and Plumbing Work: Show the following:
    - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    - c. Fire-rated enclosures around ductwork.
  7. Electrical Work: Show the following:
    - a. Runs of vertical and horizontal conduit.
    - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.

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- c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor control center locations.
    - d. Location of pull boxes and junction boxes dimensioned from column centerlines.
  8. Fire-Protection System: Show the following:
    - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
- C. Review: DEN Project Manager will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If DEN Project Manager determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, DEN Project Manager will so inform Contractor, who shall make changes as directed and resubmit.
- D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
  1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings, unless approved otherwise by DEN Project Manager.
  2. File Preparation Format: Provided in the Project BIM Execution Plan operating in Microsoft Windows operating system.
  3. File Submittal Format: Submit or post coordination drawing files as required in the Project BIM Execution Plan.
  4. The submittal must be logged in accordance with the submittal procedure
  5. For Fire Protection system; provide shop drawing and design calculations as approved by the building department. Submit as-built drawings in format as outline in BXP.
  6. For all projects, receiving official variance from the BIM requirements not utilizing BIM, coordination drawings must be submitted in acceptable digital format shall be in an industry recognized 3D AutoCAD model.
  7. BIM File Incorporation: DEN Project Manager will incorporate Contractor's coordination drawing files into Building Information Model for Revit as established for Project.
    - a. Contractor shall lead three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect or other sub-consultants.
  8. DEN Project Manager will furnish Contractor one (1) set of digital data files of Models and/or Drawings for use in preparing coordination digital data files.
    - a. The Design consultants and Contractors and Sub Contractors acknowledge and represent the following Right Of Reliance regarding Electronic Models and/or Drawing deliverables:
      - 1) Models may be transferred for allowing the recipients to develop derivative models to develop the means and methods by which to construct the project.
      - 2) It must be clear that each party be able to rely on the fact that the model furnished by others "match the 2D Contract Documents or shop drawings in their equivalent state of development"

**1.08 COORDINATION WITH DEN ASSET MANAGEMENT SYSTEM:**

- A. The full intent is to produce comprehensive record documents integrating existing data in the form of digital files and models, reconciled to actual field conditions, modifications or

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additions facilities or components of existing facilities according to new Contract Documents, and to produce record documents that could be incorporated into DEN asset management system.

- B. Utilize the BIM to link all necessary data content to the model and follow the BPXP as collaboratively modified by the Contractor, Designer, and DEN BIM Administrators and approved by DEN Project Manager
- C. Provide the following information through the execution of the Contract for all elements and element types that DEN has designated as assets. The information shall include but is not limited to:
  - 1. Project title, number, project manager contact information, contractor and subcontractor contact information
  - 2. Pertaining shop drawings
  - 3. Operational Manuals and safety information, MSDS and cut sheets, and any pertinent technical information.
  - 4. Details of all components' maintenance procedures and requirements.
  - 5. Details of all applicable warranties including but not limited to; warranty providers, manufacturers information, warranty start and finish dates, contacts , bonding company name, consent of surety,
  - 6. Equipment location (by room number and location description or grid location format acceptable to DEN Project Manager, for civil projects), equipment make, model, serial number, and other asset information as outlined in the DEN BIM DSM
  - 7. List of all spare parts including but not limited to; equipment make and model, location, submittal number or link, and suppliers reordering information
  - 8. Commissioning results, acceptance criteria, test reports, and Tab reports

**1.09 REQUESTS FOR INFORMATION (RFIS)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI through the PMIS
  - 1. DEN Project Manager will distribute the RFIs to the proper entities.
  - 2. DEN Project Manager will coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's Work or work of subcontractors
- B. DEN Project Manager has the right to reject RFIs or those that do not contain proper information and required data to properly evaluate the request and respond in a timely manner.
- C. RFIs: Use PMIS to generate RFIs.
  - 1. Attachments shall be electronic files in Adobe Acrobat PDF format.
  - 2. Attachments include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- D. For projects not using Unifier to create the RFI, the RFI must include a detailed, legible description of item needing information or interpretation and the following:
  - 1. Project name.

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2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of DOR and DEN Project Manager.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
- E. DEN Project Manager will review each RFI, determine action required, and respond. RFIs received by DEN Project Manager after 1:00 p.m. will be considered as received the following working day. Direct responses by any entity other than DEN Project Manager shall not be binding to the City and County of Denver. E-mails, and verbal conversations must be followed by an official RFI or proper contractual vehicle before it is considered for any additional compensation or time impact to the project terms and conditions.
1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of DEN Project Manager's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  2. DEN Project Manager's action may include a request for additional information, in which case DEN Project Manager's time for response will date from time of receipt of additional information.
  3. DEN Project Manager's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Title 11 - Changes In the Work, Contract Price, or Contract Time in the General Contract Conditions, 2011 Edition as amended by Special Conditions.
  4. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify DEN Project Manager in writing within five (5) days of receipt of the RFI response or the time required by Title 11 - Changes In the Work, Contract Price, or Contract Time in the General Contract Conditions, 2011 Edition
- F. RFI Log: For projects not utilizing the PMIS application, prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. The log shall include but not limited to the following data:
1. Project name.

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 013100 - PROJECT MANAGEMENT  
AND COORDINATION**

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**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

2. Name and address of Contractor.
3. Name and address of DEN Project Manager.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date DEN Project Manager's response was received.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013100**

**SECTION 013119**  
**PROJECT MEETINGS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section requires the Contractor's Project Manager, Superintendent, and Quality Control representative to attend meetings scheduled by the DEN Project Manager for the collection and dissemination of information related to the subject Contract.
- B. The DEN Project Manager will prepare the minutes of each meeting and distribute them to each of the participants.

**1.03 REFERENCE DOCUMENTS**

- A. Form CM-01, Preconstruction Meeting Agenda
- B. Form CM-62, Construction Meeting Agenda/Minutes

**1.04 OTHER MEETINGS**

- A. The Contractor shall attend all other project related meetings as directed by the DEN Project Manager.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PRECONSTRUCTION MEETING**

- A. A Preconstruction Meeting will be scheduled by the DEN Project Manager after the Contract has been signed by all parties. The purpose of this meeting is to introduce the City's Representatives to their counterparts in the Contractor's organization and to establish lines of communication between these representatives and outline some Contract requirements. The Contractor's key personnel shall attend this meeting.
- B. The DEN Project Manager will distribute a notice of this meeting, along with an agenda of the subjects to be addressed. Refer to form CM-01, Preconstruction Meeting Agenda.
- C. The DEN Project Manager will explain and discuss the responsibilities and authorities of the City, the Designer of Record, and the DEN Project Manager's organization.
- D. The Contractor shall introduce the Contractor's key personnel, subcontractors, and representatives and briefly describe each person's responsibilities.

- E. The Contractor shall prepare a presentation with the items outlined in the CM-01, Preconstruction Meeting Agenda, at a minimum.
- F. Explanations provided by the DEN Project Manager will not amend, supersede, or alter the terms or meaning of any Contract document, and the Contractor shall not claim reliance on such explanations as a defense to any breach or failure by the Contractor to perform as specified in the Contract.

### **3.02 CONSTRUCTION PROGRESS MEETINGS**

- A. Progress meetings will be scheduled weekly and more often as necessary by the DEN Project Manager to promote the competent and timely execution of the Contract.
- B. The meetings will be held at the work site or at a location selected by the DEN Project Manager. Meetings will be chaired by the DEN Project Manager or the DEN Project Manager's representative.
- C. The Contractor's key personnel shall attend unless otherwise agreed by the DEN Project Manager.
- D. At a minimum, and as directed by the DEN Project Manager, the items detailed in CM-62, Construction Meeting Agenda/Minutes shall be addressed at each meeting. The items addressed in the meeting do not waive notification or submittal requirements as required elsewhere in the Contract.
- E. The DEN Project Manager will be responsible for publishing minutes of the meetings. Refer to form CM-62, Construction Agenda/Meeting Minutes.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013119**

**SECTION 013210  
SCHEDULE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section describes the procedures and requirements for scheduling and documenting the progress of the project:
  - 1. Design Schedules
  - 2. Preliminary Construction Schedule
  - 3. Initial Project Construction Schedule (IPS)
  - 4. Monthly Progress Schedule update
  - 5. As-built Schedule
  - 6. Special reports:
    - a. Weather impacts and mitigations
    - b. Unforeseen Conditions and mitigations
    - c. Recovery Schedule and alternatives

**1.03 REFERENCE DOCUMENTS**

- A. Article 1105 – Time Extensions in the General Contract Conditions, 2011 Edition.
- B. Section 011100 "Summary of Work"
- C. Section 011400 "Work Sequence and Constraints".
- D. Section 012910 "Schedule of Values".
- E. Section 013119 "Project Meetings"
- F. Section 013300 "Submittal Procedures"

**1.04 SUBMITTALS**

- A. Submit for City acceptance the following in accordance with Section 01 33 00 – Submittal Procedures:
  - 1. Project Scheduler Qualifications
  - 2. Design Schedules
  - 3. Preliminary Project Construction Schedule
  - 4. Initial Project Construction Schedule
  - 5. Monthly Progress Update Schedules
  - 6. Time Impact Analysis, when necessary

7. As-built Schedule

B. Scheduler/Scheduling Consultant Qualifications:

1. A professional with a minimum of two (2) years of experience with scheduling design and construction projects similar in size and scope of work as this project using Oracle Primavera P6 software.
2. The scheduler shall have a comprehensive knowledge of Critical Path Method (CPM) scheduling principles and application.
3. The scheduler shall produce reports and diagrams within 24 hours of the DEN Project Manager's request and perform tasks, including but not limited to, the following:
  - a. Create, maintain and update the project design and construction schedule, including but not limited to baseline schedule management, cost and resource loading, time impact analysis, and schedule progress analysis.
  - b. Prepare monthly progress schedule updates, submit for review and incorporate the City's review comments into the schedule.
  - c. Coordinate the participation of qualified personnel to assist in the development of the initial design and construction schedule and updating of the monthly progress schedule.
  - d. Develop a Work Breakdown Schedule (WBS) to the appropriate level and be able to discuss verbally and in writing the applicability of the WBS.
  - e. Incorporate milestone dates for Owner-furnished products and deliverables.
  - f. Incorporate submittal requirements, procedures and time required for review of submittals and resubmittals.
  - g. Incorporate requirements for tests and inspections by independent testing and inspecting agencies.
  - h. Incorporate required meetings, such as Safety and Pre-work meetings.
  - i. Incorporate time required for Project closeout and Owner start-up procedures, including commissioning activities.
  - j. Adhere to contract specifications and requirements.

C. Schedule Submittal Package Requirements:

1. XER/XML file compatible with the latest version of Oracle Primavera P6
2. PLF File (if XER)
3. Narrative report including the following:
  - a. Prepare an accurate statement of the project's progress status to assist in decision making.
    - 1) Contract Milestone Dates, Current Schedule Dates
    - 2) Activities started or completed since last update
    - 3) Identify deviations from the baseline schedule and evaluate possible corrective actions.
    - 4) Logic Changes
    - 5) Critical Path Analysis / Schedule Risks
    - 6) Upcoming Activities that are impacted by or may impact stakeholders
    - 7) Change Order Activities
    - 8) Weather and other delays
  - b. A standard layout will be provided to the contractor.
4. PDF of the following:
  - a. Full Schedule View
  - b. Critical Path
  - c. Three Week Lookahead

**1.05 SCHEDULE PREPARATION REQUIREMENTS**

- A. Schedules should meet the requirements outlined in the “Schedule Approval Checklist” (Appendix 1) and the “Contractor Schedule Package” (Appendix 2). Contractor shall obtain current versions of Appendix 1 and 2 from the DEN Project Manager for use in developing the schedule. These requirements utilize the following documents as references for best practices:
1. AACE Recommended Practices (RP)
  2. USACE Project Schedules Regulation ER\_1-1-11
  3. DCMA 14-Point Schedule Assessment
- B. Projects regulated by the FAA must follow all FAA scheduling requirements, in addition to the requirements provided by DEN. In the event of a conflict between the DEN and FAA scheduling requirements, the more stringent requirement shall apply.
- C. The schedule shall satisfy, at minimum, the following criteria:
1. Prepare all Project Schedules utilizing the Critical Path Method (CPM) of network calculation to generate all schedule reporting.
  2. Show in the schedule, the proposed sequence to perform the work and dates contemplated for starting and completing the schedule activities.
  3. The scheduling of the entire project is required.
  4. Provide a schedule that is forward planning as well as a project monitoring tool
  5. Contractors, Design management personnel and DEN PMT/Stakeholders shall actively participate in its development.
  6. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate project schedule.
  7. The contractor shall keep the subcontractors and suppliers informed of the Project Construction Schedule to enable the subcontractors to plan and perform their work properly.
  8. All schedules shall comply with the City and County of Denver General Contract Conditions (GC)
  9. The schedule WBS will align with the approved schedule of values, as determined by the DEN Project Management Team, and contain, at minimum, the following milestone activities:
    - a. Start
    - b. Mobilization Complete
    - c. Substantial Completion
    - d. Final Completion
    - e. DEN reserves the right to request additional milestones to be included in all schedules as appropriate for each projects. The additional reporting requirements will be communicated by the Project Manager and PMO.
- D. Cost and Resource Loading of P6 Schedules
1. All schedules shall be cost loaded using the Lump Sum resource. Cost loading will align with the approved schedule of values, as determined by the DEN Project Management Team.
  2. Period Performance shall be stored for each schedule update provided to DEN.
  3. All schedules will be resource loaded with manhours by critical trade. Additional

resource loading requirement may be required by DEN PMT.

**E. Layout Requirements (.PLF)**

1. Project Layout Files (.PLF) will be created to standardize the information provided to DEN from the schedule, and the .PLF will be used to create the PDF schedule documents as part of the submittal package.
2. All PDF's will contain both the table and the Gantt Chart, and will be scaled to fit timescale to 1 page wide. Additionally, the following information will be displayed:
  - a. Table will contain: Activity ID, Activity Name, Baseline Start, Baseline Finish, Original Duration, Start, Finish, Duration at Completion, Finish Variance, Total Float
  - b. Gantt Chart:
    - 1) Timescale shall show the entire project schedule without cutting off any data
    - 2) In the Bar Options, the following Bars shall be displayed: Remaining Level of Effort, Actual Level of Effort, Primary Baseline, Actual Work, Remaining Work, Critical Remaining, Start Constraint, Finish Constraint, Milestone, Summary, Negative Float Bar. Activity names will be included as the bar label.
    - 3) In the Bar Chart Options, "Show Relationships" shall be checked.
    - 4) In the print layout, the header shall include at minimum the data date, current date, filter, project name, schedule update version, and contractor. The footer shall contain at minimum the legend and page count.
3. Full Schedule View will not be filtered, all activities will be shown.
4. Critical Path view will be filtered to show only the critical Activities.
5. Three Week Lookahead View will be filtered to show activities completed in the past week, or activities that are in progress or not started for the next three weeks.
6. Additional information or reports may be requested at the DEN Project Management Team's discretion, including but not limited to cash flow, manhours graph, earned value, period performance.

**F. Withholdings / Payment Rejection**

1. Failure to meet the requirements of this Section may result in the disapproval of the schedules or updates and subsequent rejection of payment requests until requirements are met.
2. If the DEN Project Manager directs schedule revisions and those revisions have not been included in subsequent Project Schedule revisions or updates, the DEN Project Manager may withhold 10 percent of pay request amount for each payment period until such revisions to the project schedule have been made.

**1.06 COORDINATION**

- A. Pre-scheduling Conference: Schedule conference at Pre-Construction meeting to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to setting up the Preliminary Project Design and / or Construction Schedule and Initial Project Construction Schedule, including, but not limited to, the following:
1. Verify availability of qualified personnel needed to develop and update schedule.
  2. Review content and format for reports.
  3. Discuss constraints, including phasing, area separations, interim milestones, stakeholder requirements and partial Owner occupancy.

4. Review milestone dates for Owner-furnished products and deliverables.
  5. Review submittal requirements and procedures.
  6. Review time required for review of submittals and resubmittals.
  7. Review time required for Shutdown request and approval.
  8. Review requirements for tests and inspections by independent testing and inspecting agencies.
  9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
  10. Review procedures for updating schedule.
  11. Review requirements for content and input of direct man-hour resources in activities.
  12. Review requirements for cost loading of activities.
  13. Coordinate Initial Project Construction Schedule with the Schedule of Values and Schedule Template.
  14. Secure time commitments for performing critical elements of the Work from entities involved.
- B. Construction Coordination: If there are activities in the schedule that are impacted by DEN, DOR, other contractors or other stakeholders, a periodic meeting will be set up with all stakeholders to evaluate the schedule and confirm dates for activities outside of the contractor's control. The contractor will be responsible for providing the most up to date schedule to all attendees in PDF format, in accordance with Section 1.3.C Submittals of Technical Specifications 013210 Schedule. The frequency of this meeting will be at the discretion of the Project Management Team.
- C. Delays, Recovery Schedules, and Requests for Extension: If the project is experiencing delays, a meeting will be set up with the designer, engineer, contractor, the PMT, and DEN Project Controls to evaluate the package provided by the contractor. The designer / contractor will be responsible for providing the most up to date schedule to all attendees in PDF format in advance of any meetings, in accordance with Section 1.3.C Submittals of Technical Specifications 013210 Schedule, as well as any supplemental information that supports requests for re-sequencing, extensions etc. Additionally, the contractor will provide all required information from sections 3.10, 3.11, and 3.12 of Technical Specifications 013210 Schedule. If DEN determines that additional coordination is required, a periodic meeting will be set up at the discretion of the Project Management Team.

## **PART 2 - PRODUCTS**

### **2.01 SOFTWARE**

- A. DEN Default Software:
1. DEN shall use the latest release of Oracle Primavera P6 for all city scheduling needs.
- B. Designer / Contractor Software:
1. Scheduling software used by the designer / contractor shall be compatible with the latest release of Oracle Primavera P6.
  2. The software and any support agreements shall be purchased at the designer's / contractor's expense from a vendor of the contractor's choosing.
  3. The City will not provide training or support services for designer / contractor purchased software.

**C. Oracle Primavera P6 Software Settings:**

1. The following settings are mandatory and required in all schedule submissions to the City. Submittals that do not meet these criteria will be rejected:
  - a. All schedules will only contain project data at the Project Level and not at the Global or EPS level. Project data includes but is not limited to calendars, risks, OBS, activity codes and user defined fields.
  - b. Time Period Administration Preferences shall remain the default “8.0 hour/day, 40 hour/week, 172 hour/month, 2000 hour/year”. Set Calendar Work Hours/Day to 8.0-hour days.
  - c. Set Schedule Option for defining Critical Activities to “Longest Path”
  - d. Set up cost loading using single lump sum resource. The resource should be named “Lump Sum”. The Price/Unit shall be \$1/hour, Default Units/Time shall be 8h/d”, and settings “Auto Compute Actuals” and “Calculate Cost from Units” selected.
  - e. Activity ID’s shall not exceed 10 characters.
  - f. Activity Names shall not exceed 30 characters, and will start with Verb/Action, followed by the work area, followed by additional information.

**PART 3 - EXECUTION****3.01 PRELIMINARY PROJECT DESIGN / CONSTRUCTION SCHEDULE SUBMISSION****A. General**

1. Within ten (10) days after the issuance of Notice to Proceed (NTP), submit the Preliminary Project Design / Construction Schedule:
  - a. If contract time is greater than 120 calendar days, submit the Schedule defining the planned operations detailed, at a minimum, for the first sixty (60) calendar days of the project for acceptance.
  - b. If contract time is shorter than 120 calendar days. submit the Schedule defining the planned operations detailed for the full contract term for acceptance.
  - c. It shall be early start and late finish constrained and logically tied as specified.
2. The Preliminary Project Design / Construction Schedule shall form the basis for the Initial Design / Project Construction Schedule specified herein and shall include all the required plan and program preparations, submissions and approvals identified in the contract. For example, Design Work Plan, Design Submittal dates and review times, Quality Control Plan, Site-specific Safety Plan, and Environmental Protection Plan, etc.
3. The DEN Project Management Team will respond within 14 days to the Preliminary Schedule submittal with either acceptance or direction to revise and resubmit.
4. In lieu of the Preliminary Project Design / Construction Schedule, the Designer / Contractor may, at the Designer’s / Contractor’s own discretion, submit the Initial Project Design / Construction Schedule at the Design Kick-Off or Preconstruction Meeting.
  - a. If the Initial Project Design / Construction Schedule is submitted in lieu of the Preliminary Project Design / Construction Schedule, the DEN Project Management Team will respond within thirty (30) days with acceptance or direction to revise and resubmission is required within ten (10) days.
5. Acceptance of Preliminary Project Construction Schedule will not constitute approval of Schedule of Values.

**3.02 INITIAL PROJECT DESIGN / CONSTRUCTION SCHEDULE SUBMISSION**

**A. General**

1. Submit the Initial Project Design / Construction Schedule for acceptance within fourteen (14) days after issuance of NTP.
2. The schedule shall demonstrate a reasonable and realistic sequence of activities which represent the Work through the entire contract performance period.
3. The DEN Project Manager will respond within 14 days with acceptance or direction to revise and resubmit.
4. The acceptance of the schedule is for general conformity to the Contract requirements and shall not constitute any relief of any Contract requirements.
5. Upon acceptance from the DEN Project Manager and DEN Project Controls, the Initial Project Design / Construction Schedule shall become the Baseline Schedule for the duration of the project.
6. The Baseline Project Design / Construction Schedule may be changed when one or more of the following events occur:
  - a. When a Change Order significantly affects the contract completion date or sequence of work.
  - b. When the Designer / Contractor elects to change the sequence or duration of work items affecting the critical path resulting in a major change that requires DEN approval.
  - c. When the City directs a change that affects a milestone dates specified in the Special Conditions or alters the length of a critical path.
7. Failure to include any work item required for performance of this Contract shall not excuse the Designer / Contractor from completing all Work within applicable completion dates, regardless of the City's acceptance of the schedule.
8. Failure of the designer / contractor to have an Initial Project Design / Construction Schedule accepted by DEN Project Manager will be considered cause for withholding progress payment.
9. This submittal shall include all package requirements included in section 1.3.C of this Technical Specifications 013210 Schedule document.

**3.03 MONTHLY PROGRESS DESIGN / CONSTRUCTION SCHEDULE UPDATES****A. General**

1. The Designer / Contractor shall submit a monthly progress schedule at the end of each month following the issuance of NTP, prior to approval of the invoice.
2. At the end of each month, the Contractor and DEN Project Manager shall agree on the progress of the work and the Contractor shall update the Construction Schedule accordingly.
3. This review does not constitute an acceptance of the Monthly Progress Schedule update and shall not be used for the purpose of modifying the accepted Baseline Project Design / Construction Schedule.
4. Failure of the Designer / Contractor to have a Monthly Progress Design / Construction Schedule accepted by the DEN Project Manager will be considered cause for withholding progress payment per Article 306 - Working Hours and Schedules and Article 909 - Additional Withholding of Progress Payments of the General Contract Conditions, 2011 Edition.
5. The Designer's / Contractor's monthly progress schedule shall include all package requirements included in section 1.3.C of this Technical Specifications 013210 Schedule document.

6. The Contractor shall provide the DEN Project Manager an electronic copy prior to and a minimum of four (4) hard copies of the Contractor's Three (3) Week Look-Ahead Schedule for review at the DEN Project Manager's weekly progress meeting.

### **3.04 AS-BUILT CONSTRUCTION SCHEDULE:**

#### **A. General**

1. After all Contract Work items are complete, the contractor shall submit an as-built Project Construction Schedule that reflects the actual sequence of construction activities, includes all change order scope of work changes and shows actual start and finish dates for all work items and milestones for acceptance by the DEN Project Manager.
2. The basis for the As-built Construction schedule will be the approved Monthly Progress Schedules.

### **3.05 RECOVERY SCHEDULE**

#### **A. General**

1. When a monthly progress schedule update indicates the Work is behind the current approved schedule, the Designer / Contractor submits a separate Recovery Schedule indicating the means by which the Designer / Contractor intends to regain compliance with the schedule.
2. No additional costs will be allowed if such expediting measures are necessary to meet the agreed completion date or dates except as provided elsewhere in the Contract Documents.
3. If the early finish date for any work item or the substantial completion date does not fall within the Contract Duration, the sequence of work or duration shall be revised by the Designer / Contractor through concurrent operations, additional manpower, additional shifts or overtime, additional equipment, or alternative construction methods until the schedule produced indicates that all significant contract completion dates, occupancy dates and milestone dates will be met.
4. Provide a narrative indicating changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
5. The narrative shall be submitted in accordance with Article 1105 – Time Extensions in the General Contract Conditions, 2011 Edition.

### **3.06 REQUEST FOR TIME EXTENSION**

#### **A. General:**

1. Provide a justification of delay to the DEN Project Manager, in accordance with the Contract provisions and clauses, for approval within 10 days of a delay occurring.
2. Prepare a time impact analysis for each DEN Change Directive, Change Notice and Contractor's Change Request to justify time extensions.
3. Added work by the City does not necessarily entitle a Designer / Contractor to a Time Extension, unless the Designer / Contractor can prove that this new added scope impacts the current critical path without manipulating any of the logic and relationships in the most recent and approved schedule.
4. The City may reject any Time Extension Request that does not include a detailed and a clear time impact analysis that shows direct impact to the most current critical path along with a detailed productivity rate calculation to justify the requested time to

execute such added work.

5. If the Designer / Contractor is granted an extension of time for completion of any milestone or contract completion date under the provisions of the Contract, the determination of the total number of extended days will be based upon the current analysis of the schedule and upon all data relevant to the extension. Such data shall be incorporated into the next monthly update of the schedule.
6. The Designer / Contractor acknowledges and agrees that delays in work items that, according to schedule analysis, do not affect any milestone dates or the Contract completion date shown on the CPM Network Schedule at the time of the delay will not be the basis for a Contract extension.

**B. Justification of Delay**

1. Provide a description of the event(s) that caused the delay and/or impact to the work. As part of the description, identify the schedule activities impacted.
2. Show that the event that caused the delay/impact was the responsibility of the City.
3. Provide a time impact analysis that demonstrates the effects of the delay or impact on the project completion date or interim completion dates.
4. Multiple impacts shall be evaluated chronologically; each with its own justification of delay. With multiple impacts, consider concurrency of delay.
5. A time extension and the schedule fragment become part of the project schedule and future schedule updates upon approval by DEN Project Controls.

**C. Time Impact Analysis (Prospective Analysis)**

1. Prepare a time impact analysis for City approval based on industry standard AACE 52R-06. Use a copy of the last approved schedule prior to the first day of the impact or delay for the time impact analysis.
2. If DEN Project Controls determines the time frame between the last approved schedule and the first day of impact is too great, prepare an interim updated schedule to perform the time impact analysis.
3. Unless approved by the DEN Project Controls, no other changes will be incorporated into the schedule being used to justify the time impact.

**D. Fragmentary Network (FragNet)**

1. Prepare a proposed fragment for time impact analysis. The proposed fragment shall sequence new activities into the project schedule to demonstrate the influence of the delay or impact to the project's contractual dates.
2. Clearly show how the proposed fragment shall be tied into the project schedule, including the predecessors and successors to the fragment activities.
3. Obtain City approval of the proposed fragment before incorporating it into the project schedule.

**E. Time Extension**

1. Time extensions will not be granted until after the City has approved the Justification of Delay, including the time impact analysis.
2. No time extension will be granted unless the delay consumes the available Project Float and extends the projected finish date ("Substantial Completion" milestone) beyond the Contract Duration.
3. The time extension will be in calendar days.

4. Actual delays that the City determines are caused by the Designer's / Contractor's own actions and result in a calculated schedule delay will not be a cause for an extension to the performance period, completion date, or interim milestone date.

F. Impact to Early Completion Schedule

1. No extended overhead will be paid for delay prior to the original Contract Substantial Completion date.

### **3.07 FAILURE TO ACHIEVE PROGRESS**

A. General:

1. If the progress falls behind the approved baseline project schedule for reasons other than those that are excusable within the terms of the Contract, the City may require submittal of a written recovery plan for approval.
2. The plan shall detail how progress shall be recovered, including which activities will be accelerated by adding additional crews, longer work hours, extra work days, etc.

B. Artificially Improving Progress

1. Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited.
2. Indicate assumptions made and the basis for logic, constraint, duration, and calendar changes used in the creation of the recovery plan.
3. Additional resources, manpower, and daily and weekly work hour changes proposed shall be evident at the work site and documented in the daily report along with the Schedule Narrative Report.

C. Failure to Perform

1. Failure to perform work and maintain progress in accordance with the supplemental recovery plan may result in an interim and final unsatisfactory performance rating and/or may result in Non-Conformance Report for corrective action directed by DEN Project Controls pursuant to other Contract provisions.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013210**

**SECTION 013223.11****CONSTRUCTION LAYOUT AND AS-BUILT SURVEYS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section covers Denver International Airport (DEN) procedures and accuracy requirements for survey services for construction layout, and as-built.
- B. Before commencing any field surveys on DEN property, the Contractor must coordinate a pre-survey preparation activities meeting. This meeting is to be arranged through the DEN Project Manager's Office with the attendance of the Contractor and the DEN Survey Section. The Contractor is responsible for obtaining DEN related survey guidance, Access to DEN survey network, Primary Control, projection parameters, and training materials from the DEN Survey at the pre-survey meeting and/or prior to beginning any survey work.
  - 1. Project Checklist, provided as part of this Specification, must be reviewed at the pre-survey preparation activities meeting. (Refer to Article 1.11.)

**1.03 REFERENCE DOCUMENTS:**

- A. Section 013223.15 "Survey Information".
- B. Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples".
- C. Latest version of Federal Aviation Administration Advisory Circular 150/5300
- D. Latest Version of DEN BIM DSM (Design Standards Manual)
- E. Latest Version of Colorado Department of Transportation (CDOT) Survey Manual.
- F. Latest Version of Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Survey Statement of Work (SSOW):
  - 1. The Contractor must develop a complete SSOW and submit it to the DEN Project Manager. The SSOW is the Contractor's written description of the Contractor's methodology for surveying services that must be provided as part of the Project, including specific features that must be surveyed, action items, timelines necessary airport resources and general information.
  - 2. SSOW must be submitted by the Contractor prior to commencement of any survey or

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- layout work on the site.
3. The SSOW will be accepted by the DEN Project Manager.
  4. Under no circumstances must the Contractor begin work until the SSOW has been accepted.
- C. Survey and Quality Control Plan (SQCP):
1. The Contractor must develop a complete SQCP and submit it to the DEN Project Manager. The SQCP is the Contractor's written description detailing the Contractor's methodologies for data collection, data safeguarding and quality assurance. Provide insight on how the Contractor must completely check all data to ensure it is complete, reliable, and accurate. Identify data safeguards used to protect the sensitive and safety critical data. Utilize a checklist based quality control process with definable and repeatable standards for each element ensuring consistency of work between different personnel within an organization. Submit the plan in a non-editable PDF.
  2. SQCP must be submitted by the Contractor prior to commencement of any survey or layout work on the site.
  3. The SQCP will be accepted by the DEN Project Manager.
  4. Under no circumstances must the Contractor begin work until the SQCP has been accepted.
- D. Weekly Project Status Report:
1. Contractor must submit a project status report in compliance with FAA AC 150/5300-18B to the DEN Project Manager every Monday by 2:00 P.M. Mountain Time, from the date of the task order until the date of Substantial Completion
  2. The Weekly Project Status Report must use format from AC 150/5300-18B
- E. Final Project Survey Report:
1. The Final Project Survey Report, must use format from AC 150/5300-18B
  2. Final Project Survey Report must be stamped and wet signed by a current Colorado Registered Professional Land Surveyor.
- F. SURVEY DELIVERABLES:
1. Contractor must submit all of the following deliverables.
  2. All raw files: GPS and Levels that is compatible with Trimble Business Center.
  3. If combining x, y from GPS and z from Levels, provide field notes and data that shows where this data came from to verify values. The GPS point numbers must match to the Level descriptions.
  4. As-built or as-constructed survey submittals must need to be in both Portable Document Format (PDF) and in AutoCAD Civil 3D. Refer to current and criteria document for direction on PDF production.
  5. All copies of original pages of field notes or electronic field notes must be in (PDF).
  6. Scanned copies of all original field notebooks used for this Project must be submitted at the end of Contract.
  7. All as-built points files must be in either CSV or TXT format.
  8. All CAD drawings must be in current approved Autodesk Civil 3D format.
    - a. CAD layers are specified in DEN BIM Design Standards Manual
    - b. DEN must provide the Autodesk Civil 3D drawing template.

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9. The as-built survey must follow the most recent Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey for all sections, as far as they are applicable to the scope of work for the project and site in question.
10. Documentation in accordance with “Table A, Optional Survey Responsibilities and Specifications” (Refer to Article 1.11.) is filled out with the required content to be submitted.
11. Hard copy of all documentation stamped and wet signature by licensed PLS responsible for the work.

**1.05 QUALITY REQUIREMENTS**

- A. Contractor – Company contracted to perform survey work under the direct supervision of a Colorado Registered Professional Land Surveyor with current FAA “Idle Certification”
- B. Subsurface Utilities Engineering (SUE): Refer to Section 011810 "Utilities Interface" for information related to underground utilities.
- C. Surveying accuracies and tolerances in control surveys, construction layouts: See CDOT Survey Manual for acceptable tolerances.

**1.06 DEN SITE SURVEY REQUIREMENTS**

- A. A site survey, construction survey, or construction as-built survey providing horizontal location and level information of surface features and both above and below ground services and utilities must be completed. This must also be annotated with information (where applicable) relating to the size, direction of and material type.
  1. When collecting utilities, Contractor must be responsible to have all exposed and installed utilities surveyed prior to being covered. If Contractor fails to survey utilities, DEN Project Manager can have the Contractor uncover the utilities so they can be surveyed.
  2. Any temporary works that remain at the completion of the project must also be surveyed.
  3. FAA and DEN Survey codes must be provided by The DEN Project Manager via DEN Survey or Designee and must be used throughout the project by Contractor for as surveyed features.
  4. The most current DEN Civil 3D template must be provided by The DEN Project Manager via the DEN BIM team. All DEN BIM requirements must be met.

**1.07 DEN ALIGNMENT MONUMENTATION**

- A. Alignment monuments must be set at their corresponding coordinates as shown on the monumentation sheet of the Alignment Plans. When monumenting the Alignment, the Contractor must verify that the latest set of Alignment plans are being used. After the Alignment monument locations are staked in the field, any necessary utility locates should be called for prior to setting the monument.
- B. All Alignment monuments set must be established within the Minimum Horizontal Accuracy Tolerance as required in this chapter for a CDOT Class B – Secondary survey.
- C. Alignment monuments must be set at the locations as shown on the Alignment Plans, which include the following locations:
  1. All angle points or changes of directions.

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2. At the beginning and ending of curves.
  3. At the points of change of direction or changes of radius of any boundary defined by circular arcs.
  4. Not to exceed 1,400 feet apart along any straight boundary line.
  5. Any other points as approved by the Survey Coordinator due to field conditions encountered during setting of the Alignment monumentation.
- D. Alignment monuments must have a witness post installed within 2 ft and facing the monument, or as accepted by DEN Survey. For setting easement monuments, the witness post requirement may be waived by DEN Survey.
- E. Use Orange Carsonite witness post:
- F. All Alignment monument caps set in the field must be stamped with the following:
1. DEN Project Code number
  2. Point number as shown on the Right of Way Plans
  3. Colorado PLS number setting the monument
- G. All Alignment monuments set in the field must be shown on the Final set of Alignment Plans in accordance with the CDOT Right of Way Manual, Chapter 2 – ROW Plans. The Colorado PLS who is in responsible charge for setting the Alignment monuments must stamp her/his number on the monument cap, and must certify on the Alignment Plans to setting of the Alignment monuments in the field.
- H. The Contractor in responsible charge of the Alignment Plans and the Contractor in responsible charge of setting the Alignment monuments in the field might not be the same individual. Therefore, care must be taken to ensure any monuments set in the field at locations different than that shown on the Alignment Plans are communicated to the Alignment plans section, and the final Alignment Plans are corrected to show these new monument locations and descriptions prior to submitting the plans to DEN Survey.
- I. Alignment monuments, witness posts, and monument box materials must be furnished by Contractor.

### **1.08 FEATURES TO BE RECORDED**

- A. Surface and Above Ground Features: The survey of surface features must include, but is not limited to:
1. Structures and Surfaces – paths, driveways, retaining walls, slabs/paved areas, significant structural footings (plinths etc.), poles/ floodlighting.
  2. Drainage Structures – headwalls, open drains, grated drains, culverts.
  3. Roads – edge of pavement, curbs, shoulders, line-marking, bridges, road furniture (NOTE – the top back and bottom face of curb, and all water channels must be surveyed and recorded).
  4. Buildings – footprints, awnings, overhangs, columns, external fixtures (stairs, ramps, plant, etc.).
  5. Fences and Gates – AOA, security, general fencing, gates and handrails.
  6. Aircraft Pavements and Movement Area Structures – finished surfaces, pavement markings, airfield markers/signage/ navigational aids, PLB and other aeronautical infrastructure;

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7. Topographical Features – general topography, embankments, earthworks platforms and surcharge.
  8. Vegetation – gardens, significant trees (>0.2' trunk diameter, decorative shrubs), vegetation stands, riparian zones.
  9. Signage – road, airfield, parking, advertising, other general signage.
  10. Survey Marks – survey control points used, any settlement plates/ monitoring points placed during works.
  11. Airfield panel corner elevations must be derived from digital levels.
- B. Services and Utilities - Prior to any backfilling or covering, information on all underground services must be obtained and documented according to DEN's modified ASCE-SUE Standards, including but not limited to:
1. Electrical (LV and HV) – top of conduit every fifty feet including horizontal and vertical bends, cables and conduits, pits/ manholes and chambers, HV cable joints, earth points and earth mats, substations/ transformers and surrounding pad, pillars, cabinets and switchboards, top of conduits.
  2. Fuel Control – top of conduit every fifty feet including horizontal and vertical bends, cables and conduits, pits/ manholes and chambers, cabinets, emergency shut-off points.
  3. Communications - top of conduit every fifty feet including horizontal and vertical bends, fiber optic, microducts, comms cables and conduits, pits/ manholes and chambers, top of conduit casing/housing.
  4. Drainage – top of pipes at fifty-foot intervals and at every vertical and horizontal bend, inspection openings, pits/ manholes and chambers, roof water drainage (downpipes, small pits/ grates).
  5. Fuel – top of pipes every fifty feet including horizontal and vertical bends, all weld points with weld numbers documented in the point description and in the field notes, pits/ manholes and chambers, valves, hydrants, earth points, test points.
  6. Sewer (note whether gravity or force main) – top of pipes every fifty feet including horizontal and vertical bends, pipes, pipe inverts, pipe outflows, inspection openings, pits/ manholes and chambers, vent pipes, pump stations and associated components.
  7. Water (differentiate between potable and recycled) – top of pipes every fifty feet including horizontal and vertical bends, pits/ manholes and chambers, valves (and type), meters, taps, hydrants, tanks, pumps, irrigation control.
  8. Compressed Air – top of pipes every fifty feet including horizontal and vertical bends, hoses and other fixtures.
  9. Natural Gas / Petroleum– top of pipes every fifty feet including horizontal and vertical bends, valves, tanks, meters.
- C. Sufficient points must be recorded to ensure that the extremities of all surface features, structures and footings are clearly defined and all bends, intersections, and changes of gradient are accurately recorded. The distance between points of location should generally be about 50 feet and must not exceed 100 feet. All curves must be accurately defined using a minimum of three points (two tangent points and one midpoint).
- D. Where actual positions of linear features deviate from a straight line, sufficient additional points of location must be provided to define the deviation – horizontal and/or vertical change in directions.
- E. For systems, utilities, and features not identified herein, refer to PM for direction on capture

requirements

### 1.09 SURVEY METHODOLOGY – SERVICES AND UNDERGROUND FEATURES

- A. Sufficient points must be recorded to ensure that the extremities of all pits, manholes, and any other features related to the service are clearly defined and all bends, joints, intersections, changes of gradient, and fittings on or along the service, pipe or conduit are accurately recorded. All curves must be accurately defined using a minimum of three points (two tangent points and one midpoint). Where actual positions of linear features deviate from a straight line, sufficient additional points of location must be provided to define the deviation – horizontal and/or vertical change of directions.
- B. The maximum distance between points of location along services must not exceed 50 feet. Horizontal and vertical locations must be surveyed on the top of the utility and must be labeled as “top”. Inverts measurements must also be taken in manholes and must be labeled.
- C. The Contractor must record and annotate all services and utilities with information relating to the size, direction of and material type. The Contractor must record and clearly differentiate between the communication service providers and DEN and/or FAA communications infrastructure.
- D. The Contractor must record the size and orientation of all grates, pits and manholes. Grates and pits must be recorded using a minimum of three corner or edge points. Pit/ manhole chambers only need to be located and where the extents of the chamber extend past the extremities of the pit at surface level. In all instances, any thrust blocks or concrete cover/ protection over services must be located, showing depth.

### 1.10 EXISTING FEATURES AND SERVICES

- A. Existing Services: where the existence of services and other features on the site of the Work and the Work exposes or interacts with these existing services, the Contractor must locate and record the details of all such features and services.
- B. Tunnel Boring: The Contractor must provide records (logs, profiles etc.) relating to all tunnel boring undertaken as part of the Project. Where appropriate this information must be incorporated into the as-built site survey. Where the contract drawings do not show the existence of certain utilities and features and the Work exposes or interacts with the utilities and features, these must be located and recorded by the Contractor.
- C. Services Alteration/ Abandonment / Demolition: Where existing infrastructure, building services and/or utilities are demolished or services realigned or abandoned this information must be reflected within the as-built site survey. A distinction must be made between services (or part services) which have been abandoned (but left in the ground) and those that have been physically removed.

### 1.11 SURVEY CHECK LIST

	Yes	No	N/A	Project Kickoff Phase
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor meet with DEN PM obtain the data standards and general requirements for data gathering?
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor meet with Airport Survey Office to obtain airport survey control points, projection parameters, and airport survey training materials?
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Survey Statement of Work to DEN PM?

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4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Geodetic Verification Survey to DEN PM?
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Survey Control Plan to DEN PM?
6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide Imagery Plan to DEN PM? (Only required if collecting aerial imagery)?
7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the FAA accept survey plans?
	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>Construction Phase (As-Built)</b>
8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor perform field survey of project site to collect accurate as-built data?
9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the Contractor provide DEN PM with subsurface utility data?
10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Each week, did the Contractor provide DEN PM with Project Status Reports?
11	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the Contractor provide DEN PM with 25% as-built data in both CADD and GIS formats including all attribute information and metadata?
12a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did DEN PM report 25% QA findings via email to Contractor?
12b	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If required, did the Contractor provide DEN PM with 50% as-built data in both CADD and GIS formats including all attribute information and metadata?
12c	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If applicable, did DEN PM report 50% QA findings via email to Contractor?
12d	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If required, did the Contractor provide the DEN PM with 75% as-built data in both CADD and GIS formats including all attribute information and metadata?
12e	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	If applicable, did DEN PM report 75% QA findings via email to Contractor?
13	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did the Contractor provide DEN PM with 100% as-built data in both CADD and GIS formats including all attribute information and metadata?
14	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did Contractor provide DEN PM with a completed Final Survey Report?
15	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Did DEN PM report QA findings via email to Contractor?

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.01 CONSTRUCTION LINES AND GRADES**

- A. The Contractor must make surveys and layouts as necessary to delineate the Work. The Contractor must make the surveys for the proper performance of the Work. As a part of such surveys, the Contractor must furnish, establish, and maintain in good order survey control points that may be required for the completion of the Work subject to the approval of the DEN Project Manager as to their location, sufficiency and adequacy. However, such approval by the DEN Project Manager must not relieve the Contractor of responsibility for the accuracy of the Contractor's survey work.
- B. The DEN Project Manager must have the right to check surveys and layouts made by the Contractor prior to approving any of the Work. The Contractor must give advance notice of not less than forty-eight (48) hours to the DEN Project Manager to enable such checking prior to placing any work. The Contractor must furnish assistance as may be required for

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checking purposes when so requested by the DEN Project Manager.

- C. The Contractor must furnish skilled labor, instrument platforms, ladders and such other temporary structures as may be necessary for making and maintaining points and lines in connection with the surveys required.
- D. The DEN Project Manager may draw the Contractor's attention to errors or omissions in lines or grades, but the failure to point out such errors or omissions must not give the Contractor any right or claim nor must in any way relieve the Contractor of obligations according to the terms of this Contract.
- E. The Contractor's instruments and other survey equipment must have current certification from manufacturer's representative Surveys must be performed under the direct supervision of a current Colorado Registered Licensed Land Contractor.
- F. Field Notes:
  - 1. The Contractor must record surveys in field notebooks or as electronic field notes, whichever is more appropriate to the type of survey work.
  - 2. If the DEN Project Manager finds errors in the field notes DEN must have the Contractor correct and resubmit the notes. This review does not relieve the Contractor from the responsibility of maintaining accurate survey data. Whichever method of note-taking the Contractor starts with, the Contractor must use the same method throughout the Contract duration.
- G. The DEN Project Manager may at any time use line and grade points and markers established by the Contractor. The Contractor's surveys are a part of the Work and may be checked by the DEN Project Manager or the DEN Project Manager's representatives at any time.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013223.11**

**SECTION 013223.15****SURVEY INFORMATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section covers Denver International Airport (DEN) procedures and accuracy requirements for survey control.
- B. Before commencing any field surveys on DEN property, the Contractor must coordinate a pre-survey preparation activities meeting. This meeting is to be arranged through the DEN Project Manager's Office with the attendance of the Contractor and the DEN Survey Section. The Contractor is responsible for obtaining DEN related survey guidance, Access to DEN survey network, Primary Control, projection parameters, and training materials from the DEN Survey at the pre-survey meeting and/or prior to beginning any survey work.
- C. Survey Project Checklist, provided after the end of this Section, will be reviewed at the pre-survey preparation activities meeting.

**1.03 REFERENCE DOCUMENTS:**

- A. Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples".
- B. Latest version of Federal Aviation Administration Advisory Circular 150/5300
- C. Latest Version of DEN BIM DSM (Design Standards Manual)
- D. Latest Version of Colorado Department of Transportation (CDOT) Survey Manual.
- E. Latest Version of Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Survey Statement of Work (SSOW):
  - 1. The Contractor must develop a complete SSOW in accordance with Specification Section 013223.11, "Construction Layout and As-Built Surveys".
- C. Survey and Quality Control Plan (SQCP):
  - 1. The Contractor must develop a complete SQCP in accordance with Specification Section 013223.11, "Construction Layout and As- Built Surveys".

**1.05 QUALITY REQUIREMENTS**

- A. Equipment Calibration:
1. Equipment must be regularly checked, and calibrated for accuracy at the beginning of any survey project to ensure that the equipment is operating appropriately. Errors due to poorly maintained or malfunctioning equipment will not be accepted. If any equipment errors are found to exist they must be reported to the DEN Survey prior to the start of any surveying. These errors must be verified and eliminated prior to performing any survey work. For projects lasting longer than six (6) months, the checking, and calibration of equipment must be repeated. Furthermore, documentation must verify such equipment has met acceptable tolerances.
  2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.
- B. See CDOT Survey Manual for acceptable procedures for calibrating equipment electronic survey instruments adjustments, calibration, or repairs:
1. All electronic survey instruments must be repaired, adjusted, or calibrated only by an authorized equipment vendor or manufacturers service department.
  2. A calibration check on all types of electronic survey instrumentation is essential to obtain and maintain the tolerances required for any DEN project. At the beginning of any DEN project, all survey equipment utilized to perform the survey must be calibrated by the surveyor in charge of the Project.
  3. See CDOT Survey Manual for acceptable procedures for calibrating equipment.
- C. Baseline Calibration Requirements:
1. See CDOT Survey Manual for the procedures to check the survey equipment and the method of reporting the findings to the DEN Project Manager and the DEN Survey Section.
  2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.

**1.06 SURVEY CONTROL**

- A. DEN utilizes its own local coordinate system that is tied to the National Spatial Reference System (NSRS). The DEN Survey Section will provide the data required to use this coordinate system during the mandatory pre-survey preparation activities meeting. The DEN Survey Section will also provide coordinates for all Primary Control Points based upon the location of the Project.
- B. The coordinates of the Primary Airport Control Station (PACS) and Secondary Airport Control Station (SACS) were correct at the time of installation (or subsequent date listed on the plan) but may be subject to the effects of subsequent subsidence and/ or disturbance. Marks with any noticeable signs of disturbance, damage, or location out of tolerance must be reported so that they can be repaired and/ or noted on the control plan. In addition, any marks that have been or will be destroyed either before or during Works must be noted and mentioned in the Survey Statement of Work and the Survey and Quality Control Plan. If removed or destroyed, the Contractor will create a plan and must replace the PACS or SACS.

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- C. DEN is based on the North American Vertical Datum of 1988 (NAVD 1988). Vertical Control and Bench Marks must be tied into this datum. DEN has existing established National Geodetic Survey (NGS) vertical stations around its property and these points must be used in all DEN projects. Project control points must be established by performing measurements with a digital level from at least two NGS vertical stations that are given by the DEN Survey Section. The benchmarks used to establish ties to the datum must be shown in the Contractor's notes and on the CSP.
- D. The Contractor will be provided survey control from the DEN Survey Section. If the nearest NGS Vertical Station is a considerable distance from the site, the Contractor may establish a Temporary Survey Control Point (TSCP) near the site. Appropriate survey procedures must be used to establish any additional TSCP. A minimum of 3 TSM must be established for the project. Each must be visible and tied to at least 2 separate TSCP or PACS and/or SACS. It is the Contractor's responsibility to verify the stability of the mark over the life of the project. Where unacceptable discrepancies in control marks due to land settlement, disturbance or from other factors are apparent, the Contractor must refer the matter to DEN Project Manager for resolution prior to the continuation of Work.
- E. Horizontal Control is based on a local coordinate system. The Contractor must establish reliable horizontal control that will last the duration of the Project. Where unacceptable discrepancies in control marks due to land settlement, disturbance or from other factors are apparent, the Contractor must refer the matter to DEN Project Manager for resolution prior to the commencement of Work. The horizontal control establishing ties to the datum must be shown in the Contractor's notes and on the CSP.
- F. Geodetic Verification Survey Instructions and Procedures:
1. The geodetic verification survey is created to insure the stable position of the DEN Primary control points that are used to reference the TSCP to the NSRS. Acceptable monuments will be identified by the DEN Survey Section and will be limited to monuments of the NSRS with permanent identifiers (PIDS) and published positions and elevations. Temporary design/construction control points established for such project will be referenced by direct measurement to at least two (2) separate NGS control stations.
    - a. The Contractor must recover each identified monument and determine its condition, stability, and suitability for the intended use. A location sketch and visibility diagram will be prepared for each station. A minimum of three (3) digital photographs, one of each type described in AC 150/5300-18B, Section 1.5.2.1, will be captured, captioned, and properly named. A recovery note will be filed with NGS if no current recovery is shown in the NSRS database.
    - b. After recovering the identified NSRS NGS control stations that are located on DEN property, the procedure to verify the control points are as follows:
      - 1) DEN has created its own Virtual Reference System (VRS) Network that will be used on all survey projects. This network will be known as DENVRS.
        - a) This system is comprised of hardware and software designed to facilitate real-time GPS/GNSS positioning based on a set of reference stations.
        - b) DEN has created a control network that incorporates fifteen (15) Primary Control Points tied together with the reference stations for the DENVRS,
        - c) This network, in turn, is tied to the National Spatial Reference System (NSRS).
        - d) DEN will be monitoring the stations on an annual basis and the primary control points on an annual basis and the primary control points on a quarterly basis.
      - 2) The Consultant is required to validate the DENVRS by observing at least two (2) Primary control points using a Fast Static method

- a) Fast Static surveys allow for systematic errors to be resolved when high accuracy positions are required by collecting simultaneous data between stationary receivers for a shorter period of time than that of Static surveys. DEN will require an observation time of (15) minutes on all Primary control points. Each baseline between adjacent intervisible control points must be observed at least twice.
  - 3) The results must be reviewed and approved by the DEN Survey Office, allowing at least seventy-two (72) hours to review and either approve or reject the temporary control. All temporary control points **MUST BE** accepted before any design survey work can commence.
  - 4) Obtain elevation checks either from GPS observations or from digital levels. The distances must agree within, plus or minus, three ( $\pm 3$ ) cm; the difference in ellipsoidal height must agree within, plus or minus, four ( $\pm 4$ ) cm, and the difference in orthometric height must agree within, plus or minus, five ( $\pm 5$ ) cm. If the tolerances are not met the data must be recollected.
  - 5) Provide the results or the comparisons as part of the observational data in a report to the DEN Project Manager to be reviewed and approved by the DEN Survey Section prior to the start of construction and include this approved report in the final report.
  - 6) Submit a Recover Observe Report for the NGS horizontal control stations to the NGS. Refer to <https://www.ngs.noaa.gov/GPSONBM/Report.shtml> for the report format.
- G. Limitations and Additional Information for NGS Control Stations and NGS Benchmarks:
1. The use of control monuments and projection parameters for construction layout other than those shown on the Contract Drawings or furnished by or approved by the DEN Survey Section is **STRICTLY PROHIBITED**. Use of other monuments is solely at the risk of the Contractor.
  2. The DEN Survey Section will provide the Contractor with the projection parameters and any assistance in implementing the coordinate system. It is up to the Contractor to use the correct methodology in performing any survey task which must be submitted to the DEN Project Manager and reviewed during the pre-survey preparation activities meeting.
  3. The DEN Project Manager will need all pertinent data from the Contractor to check and verify that the Contractor implemented the coordinate system correctly.
- H. Modifications to AC 150/5300-18B, Section 2.6.10.1.1, Verification of Survey Marks:
1. DEN requires Contractor to verify the unmoved position and elevation of both the PACS and SACS for any airside projects and any two (2) DEN approved NGS control stations for any landside project.
  2. The Contractor must follow the same verification procedure as stated in Section G above.
- I. Reporting Damage or Errors of NGS Control Stations:
1. Report damaged or destroyed airport control points, bench marks, and section corner monuments promptly to the DEN Project Manager.
    - a. If section corner monuments are damaged or destroyed during construction activities, such points must be re-established pursuant to Laws of the State of Colorado Regulating the Practice of Land Surveying by a current Registered Professional Land Contractor in the State of Colorado.
    - b. If NGS control stations or NGS bench marks are damaged, moved, altered, or destroyed by the Contractor, DEN's cost of reestablishing such points must be

- borne by the Contractor.
- c. DEN will not be responsible for any increased costs or delays to the Contractor relating to reference points, airport control points, or bench marks which are damaged, moved, altered, or destroyed by the Contractor or its, suppliers, agents or employees or other Contractors working on the site.
2. Report alleged errors in NGS control stations or NGS bench marks promptly to the DEN Project Manager.
    - a. Discontinue use of NGS control stations or NGS bench marks alleged to be in error until the accuracy of points can be verified or as directed.
    - b. Claims for extra compensation for alteration or reconstruction allegedly due to errors in NGS control stations or NGS benchmarks will not be allowed unless original NGS control stations and NGS bench marks still exist or substantiating evidence proving error is furnished by the Contractor, and unless the Contractor has reported such errors to the DEN Project Manager as specified herein.

### **1.07 TEMPORARY SURVEY CONTROL**

- A. The Contractor **MUST** set a minimum of either 'chiseled X' in concrete; a drill hole with lead and tack in concrete; a PK nail with shiner in asphalt or concrete or a 5/8" rebar with plastic cap in natural ground. An 'Inked X' set as a control point is **UNACCEPTABLE**.
- B. When a Contractor establishes TSCP for DEN survey work the Contractor **MUST** follow FAA guidelines. All TSCP must be referenced to the National Spatial Reference System (NSRS) using the NGS control stations provided by the DEN Survey Section. Temporary control may be necessary based on project site location. Below are the acceptable means to establish temporary geodetic control for DEN design or construction projects:
  1. Temporary control must be established under close cooperation with the DEN Survey Section following the procedures outlined in AC150/5300-16 "General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to National Geodetic Survey" only in the following cases:
    - a. Large airport construction projects that significantly changes the airport geometry and would trigger the need to acquire new Digital Stereo Imagery following AC 150/5300-17 "General Guidance and Specification for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey". Examples include a new runway and taxiway complex, significant modification of existing runway or taxiway system, development of new outboard deice pad complex or establishment of new mid airfield concourse and terminal complex. The size and complexity of the Project will dictate the need to acquire new digital stereo imagery for significant construction.
    - b. Construction that establishes a new ILS CAT II/III Operations.
    - c. New Instrument Development Procedure.
    - d. New Airport Layout Plan Survey Update.
    - e. New Airport Obstruction Chart Update.
    - f. New Airport Mapping Database.
  2. On DEN projects, the Contractor, may use TSCPs on their project site. These TSCP must be referenced to the nearest two (2) DEN primary control points and **MUST BE** referenced vertically to two (2) different NGS benchmarks. Also, all Contractors **MUST** obtain permission to establish TSCPs on DEN property by means of communicating with the DEN Survey Section.
  3. In addition, all vertical control **MUST BE** established only using a digital level unless otherwise authorized by the DEN Survey Section.
  4. Minimum Construction Horizontal and Vertical Accuracy Tolerance:

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 013223.15 – SURVEY INFORMATION****DENVER INTERNATIONAL AIRPORT**  
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- a. Adjustments:
    - 1) No adjustment of the survey field data will be permitted without the written consent of the DEN Project Manager. If it is determined that an adjustment is necessary, a weighted least squares adjustment method is recommended.
  - b. Primary NGS vertical stations values must be held unless the Contractor has determined that there is an issue with one of the values. If this is the case, the Contractor must notify the DEN Project Manager to determine which other Primary stations can be used.
  - c. Secondary Control Project Benchmark Minimum Vertical Accuracy Tolerance:
    - 1) Setting of secondary control benchmarks must meet the Minimum Vertical Accuracy Tolerance of the square root of the total horizontal distance of the level loop in miles multiplied by 0.035 feet.
    - 2) The results of this evaluation must be recorded in the field book for each differential level loop. At least two (2) established NGS benchmarks on the same datum must be used to verify that the starting mark has not been disturbed.
5. Whether establishing TSCPs or not, the Contractor must set up a Pre-Survey Preparation Activity meeting with the DEN Project Manager to discuss Geodetic Control Verification, obtain pertinent survey data, and projection parameters before the commencement of any survey work.
  6. If TSCPs are needed, the Contractor can set and collect temporary control while performing as outlined in Part 1 of this Section. Once the data is collected the Contractor is required to submit all pertinent data to the DEN Project Manager. This data must include all GPS raw data in a Trimble format with an Excel spreadsheet that displays the comparison from each observation of the NGS control stations. The comparison must include showing the delta northings, delta eastings, and delta elevations for each redundant pair of control points Contractor Only the redundant values of the TSCPs should be averaged. The results must be reviewed and accepted by the DEN Project Manager, allowing at least seventy-two (72) hours to review and either approve or reject the temporary control. All TSCPs MUST BE approved before any survey work can commence.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013223.15**

**SECTION 013223.19****QUANTITY SURVEYS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section covers Denver International Airport DEN procedures and accuracy requirements for survey services for construction layout, as-built and quantity surveys.
- B. Before commencing any field surveys on DEN property, the Contractor must coordinate a pre-survey preparation activities meeting. This meeting is to be arranged through the DEN Project Manager's Office with the attendance of the Contractor, the Contractor's surveyor, and the DEN Survey Section. The Contractor is responsible for obtaining DEN related survey guidance, primary control stations, projection parameters and training materials from the DEN Survey Section prior to beginning any survey work.
- C. Reference Contract General Conditions.

**1.03 REFERENCE DOCUMENTS:**

- A. ~~Section 013326 "Survey Control"~~.
- B. Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples".
- C. Latest version of Federal Aviation Administration Advisory Circular 150/5300
- D. Latest Version of DEN BIM DSM (Design Standards Manual)
- E. Latest Version of Colorado Department of Transportation (CDOT) Survey Manual.
- F. Latest Version of Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Weekly Project Status Report:
  - 1. Contractor must submit a project status report in compliance with FAA AC 150/5300-18B to the DEN Project Manager every Monday by 2:00 P.M. Mountain Time, from the date of the task order until the date of Substantial Completion
  - 2. The Weekly Project Status Report must use format from AC 150/5300-18B
- C. Final Project Survey Report:

1. The Final Project Survey Report, must use format from AC 150/5300-18B
2. Final Project Survey Report must be stamped and wet signed by a current Colorado Registered Professional Land Surveyor.

### **1.05 QUALITY REQUIREMENTS**

#### **A. Equipment Calibration:**

1. Equipment must be regularly checked, and calibrated for accuracy at the beginning of any survey project to ensure that the equipment is operating appropriately. Errors due to poorly maintained or malfunctioning equipment will not be accepted. If any equipment errors are found to exist they must be reported to the DEN Survey prior to the start of any surveying. These errors must be verified and eliminated prior to performing any survey work. For projects lasting longer than six (6) months, the checking, and calibration of equipment must be repeated. Furthermore, documentation must verify such equipment has met acceptable tolerances.
2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.

#### **B. See CDOT Survey Manual for acceptable procedures for calibrating equipment electronic survey instruments adjustments, calibration, or repairs:**

1. All electronic survey instruments must be repaired, adjusted, or calibrated only by an authorized equipment vendor or manufacturers service department.
2. A calibration check on all types of electronic survey instrumentation is essential to obtain and maintain the tolerances required for any DEN project. At the beginning of any DEN project, all survey equipment utilized to perform the survey must be calibrated by the surveyor in charge of the Project.
3. See CDOT Survey Manual for acceptable procedures for calibrating equipment.

#### **C. Baseline Calibration Requirements:**

1. See CDOT Survey Manual for the procedures to check the survey equipment and the method of reporting the findings to the DEN Project Manager and the DEN Survey Section.
2. The Contractor must submit to the DEN Project Manager written proof that survey equipment has been checked and calibrated before commencing any survey work. If repairs are made, documentation of such repairs from an authorized equipment vendor must be submitted.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 QUANTITY SURVEYS FOR PAYMENT**

- A. When the specifications or the DEN Project Manager require items in the Schedule of Prices and Quantities to be measured by surveying methods, the Contractor must perform the surveys.
- B. All such surveys, including control surveys run for establishing the measurement reference lines, must be performed in the presence of the DEN Project Manager or the DEN Project

Manager's representative who will witness the surveying operation and who will acknowledge receipt of the field notes or keep duplicate field notes, at the DEN Project Manager's option.

- C. The Contractor must reduce the field notes and calculate final quantities for payment purposes. The note reductions and calculations must be given to the DEN Project Manager.

#### **PART 4 - MEASUREMENT**

##### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013223.19**

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SECTION 013223.19 – QUALITY SURVEYS**

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**SECTION 013233****PHOTOGRAPHIC DOCUMENTATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for the following:
  - 1. Preconstruction photographs.
  - 2. Periodic construction photographs.
  - 3. Final Completion construction photographs.
  - 4. Preconstruction video recordings.
  - 5. Periodic construction video recordings.
  - 6. Web-based construction photographic documentation.

**1.03 REFERENCE DOCUMENTS:**

- A. Section 013300 "Submittal Procedures"
- B. Section 017720 "Contract Closeout"
- C. Section 017900 "Demonstration and Training"

**1.04 ALTERNATES**

- A. Refer to Section 012300 "Alternates"

**1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For photographer.
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- C. Digital Photographs: Submit image files within three (3) days of taking photographs.
  - 1. Digital Camera: Minimum sensor resolution of 10 megapixels.
  - 2. File Format: Minimum 3200 by 2400 pixels, in unaltered .RAW original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
  - 3. Identification: Provide the following information with each image description in file metadata tag:
    - a. Project title and Project number.
    - b. Name and contact information for photographer.

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**TECHNICAL SPECIFICATIONS**  
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- c. Name of DEN Project Manager.
  - d. Name of Contractor.
  - e. Date photograph was taken.
  - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    - 1) Include work order number or change order number if applicable.
  - g. Unique sequential identifier keyed to accompanying key plan.
  - h. Photograph number.
- D. Video Recordings: Submit video recordings within seven (7) days of recording.
1. Submit video recordings in an electronic format acceptable to DEN Project Manager by posting to Project Web site. Recordings shall be high-resolution 1080p with a minimum framerate of 60Hz.
  2. Identification: With each submittal, provide the following information:
  3. Name of Project.
  4. Name and address of photographer.
  5. Name of DEN Project Manager.
  6. Name of Contractor.
  7. Date video recording was recorded.
  8. Description and key plan of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
  9. Weather conditions at time of recording.
- E. Web-Based Photographic Documentation: Submit time-lapse sequence video recordings simultaneously with recording.
1. Submit time-lapse sequence video recordings by posting to Project Web site.
  2. Identification: For each recording, provide the following information:
    - a. Name of Project.
    - b. Name and contact information for photographer.
    - c. Name of DEN Project Manager.
    - d. Name of Contractor.
    - e. Date(s) and time(s) video recording was recorded.
    - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    - g. Weather conditions at time of recording.

**1.06 QUALITY ASSURANCE**

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.
- B. Web-Based Photographic Documentation Service Provider: A firm specializing in providing photographic equipment, Web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project for not less than three years.

**1.07 USAGE RIGHTS**

- A. Obtain and transfer copyright usage rights from photographer to City and County of Denver for unlimited reproduction of photographic documentation.

## **PART 2 - PRODUCTS**

### **2.01 PHOTOGRAPHIC MEDIA**

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 10 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.
- B. Digital Video Recordings: Provide high-resolution 1080p with a minimum framerate of 60Hz in electronic format acceptable to DEN Project Manager.

### **2.02 WEB-BASED PHOTOGRAPHIC DOCUMENTATION**

- A. Project Camera: Provide fixed exterior camera installation, mounted to provide unobstructed view of construction site from location approved by DEN Project Manager.
1. Provide one fixed-location camera(s), with the following characteristics:
    - a. Static view or remotely controllable view with mouse-click user navigation for horizontal pan, vertical tile, and optical zoom of 500 percent minimum.
    - b. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.
- B. Wireless Hand-Held Camera: Provide portable camera system capable of producing images complying with requirements in this Section, with wireless transmission to service provider's network enabling a live image stream viewable by multiple parties.
1. Provide battery charger, spare battery pack, base station hub, and base station connections in a number and distribution adequate to enable wireless camera operation throughout Project site. Contractor responsible for ensuring camera stays in operation.
  2. Provide power supply, active high-speed data connection to service provider's network, and static public IP address at base station hub. Provide power supply, conduit, and data wiring between base station hub and base station connections.
- C. Web-Based Image Access: Password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
1. Provide public viewer open access to most recent project camera image.

## **PART 3 - EXECUTION**

### **3.01 CONSTRUCTION PHOTOGRAPHS**

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to show clearly the Work. Photographs with blurry or out-of-focus areas will not be accepted.
1. Maintain key plan with each set of construction photographs that identifies each photographic location.

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- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software. Provide commercial quality, digital color photographs in PDF format. PDF file shall be security-free, bookmarked by date with all photos rotated to the correct orientation. Identify the following information on each photograph on the lower right corner.
1. Subject description (include work order number or change order number if applicable)
  2. Station point of camera and direction of view. Include letter size diagram of project indicating Station point
  3. Date and time each photo was taken
  4. Name of Contractor.
  5. Photograph number
  6. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to DEN Project Manager.
- D. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by DEN Project Manager.
1. Flag construction limits before taking construction photographs.
  2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
  3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
  4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
  5. Haul route, laydown yard, and other locations as directed by DEN Project Manager.
- E. Periodic Construction Photographs: 20 photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- F. DEN Project Manager-Directed Construction Photographs: From time to time, DEN Project Manager will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.
- G. Time-Lapse Sequence Construction Photographs: Take 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
1. Frequency: Take photographs monthly, coinciding with the cutoff date associated with each Application for Payment.
  2. Vantage Points: Following suggestions by DEN Project Manager and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
    - a. Commencement of the Work, through completion of subgrade construction.
    - b. Above-grade structural framing.
    - c. Exterior building enclosure.
    - d. Interior Work, through date of Substantial Completion.

- H. Final Completion Construction Photographs: Take 20 color photographs after date of Substantial Completion for submission as project record documents. DEN Project Manager will inform photographer of desired vantage points.
1. Include date stamp.
- I. Additional Photographs: DEN Project Manager may request photographs in addition to periodic photographs specified. Additional photographs shall be paid for by Change Order and are not included in the Contract Sum.
1. Three days' notice shall be given, where feasible.
  2. In emergency situations, take additional photographs within 24 hours of request.
  3. Circumstances that could require additional photographs include, but are not limited to, the following:
    - a. Special events planned at Project site.
    - b. Immediate follow-up when on-site events result in construction damage or losses.
    - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    - d. Substantial Completion of a major phase or component of the Work.
    - e. Extra record photographs at time of final acceptance.
    - f. DEN's request for special publicity photographs.

### **3.02 CONSTRUCTION VIDEO RECORDINGS**

- A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.
- B. Recording: Mount camera on tripod before starting recording unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.
- C. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
1. Confirm date and time at beginning and end of recording.
  2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.
- D. Preconstruction Video Recording: Before starting construction, record video recording of Project site and surrounding properties from different vantage points, as directed by DEN Project Manager.
1. Flag construction limits before recording construction video recordings.
  2. Show existing conditions adjacent to Project site before starting the Work.
  3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of construction.
  4. Show protection efforts by Contractor.
- E. Periodic Construction Video Recordings: Record video recording monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show

status of construction and progress since last video recordings were recorded. Minimum recording time shall be 30 minutes(s).

- F. Time-Lapse Sequence Construction Video Recordings: Record video recording to show status of construction and progress.
1. Frequency: During each of the following construction phases, set up video recorder to automatically record one frame of video recording every five (5) minutes, from same vantage point each time, to create a time-lapse sequence of 30 minutes in length as follows:
    - a. Commencement of the Work, through completion of subgrade construction.
    - b. Above-grade structural framing.
    - c. Exterior building enclosure.
  2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.
  3. Vantage Points: Following suggestions by DEN Project Manager and Contractor, photographer shall select vantage points.

### **3.03 WEB-BASED CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION**

- A. Live Streaming Construction Site Images: Provide Web-accessible image of current site image from fixed or viewer-controlled location camera(s), updated at 15 minute intervals during daytime operation.
- B. Time-Lapse Sequence Construction Site Recordings: Provide video recording from a fixed-location camera to show status of construction and progress.
1. Frequency: Record one frame of video recording every 15 minutes, from same vantage point each time, to create a time-lapse sequence of construction activities.
  2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.
- C. Maintain cameras and Web-based access in good working order according to Web-based construction photographic documentation service provider's written instructions until Final Completion. Provide for service of cameras and related networking devices and software.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013233**

**SECTION 013300**  
**SUBMITTAL PROCEDURES**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section summarizes the requirements for the submittal of documents to the DEN Project Manager that are defined in these Specifications. It also describes the procedures for "supplemental" submittals.
- B. The Contractor must follow all the requirements of the procedures and the product details and keep all the submittals current and approved prior to any placement of work.

**1.03 SUBMITTAL SCHEDULE**

- A. The Contractor shall provide a submittal schedule within 14 days after Notice to Proceed. The Submittal Schedule shall be directly related to the CPM schedule, shall identify all the submittals, and shall include the following information for each submittal item
1. Specification section, Contract article, or special condition.
  2. Specification Subparagraph.
  3. Item description.
  4. Date the submittal shall be submitted.
  5. Name of subcontractor or supplier.
- B. The submittal schedule shall be kept current by the Contractor and submitted with the progress payment requests.
- C. For large files that cannot be loaded or e-mailed through the electronic Project Manager application (Unifier), submit the files on a CD, DVD, or USB flash drive media.

**1.04 ELECTRONIC SUBMITTALS**

- A. Before the initiation of the submittal process, coordinate and ensure that all submittals comply and follow the requirements of the DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and the DEN BIM PXP.
- B. Submit request for progress payment applications utilizing TEXTURA software as instructed by DEN Project Manager.
- C. Submit Subcontractor's Contract information required by the City and County of Denver Small Business Office as instructed by DEN Project Manager.
- D. Submit original electronic copies of all City and County of Denver Development Department/ Building Inspection Department Approved drawings including all approvals of Deferred Submittals; including but not limited to shoring plans, Fire Protection distribution

plans, and structural shop drawings to DEN Project Manager as Informational Submittals. The lack of approval of the Denver Development Services on any document shall be basis for rejection of Work and non-compliance.

1. NOTE: Only original copies shall be accepted. Scans will not be accepted.
- E. Submit electronically scanned copies of all documents required by Chapter 17 “Special Inspection and Testing” of the International Building Code 2009 as amended by City and County of Denver 2011. Keep scale and clarify dimension where electronic copies are not as originally scaled and dimensioned.
- F. All submittals shall be delivered to the DEN Project Manager utilizing the Primavera Construction Manager program (PCM) as attachments and as separate file when files are too large to attach or of an electronic media that is not supported by PCM or Utilizing the EPPM Unifier software uploaded to the share drive Unifier’s project site when directed by DEN Project Manager.
  1. Acceptable electronic formats
    - a. Print document format (pdf) shall have no security and bookmark every applicable submittal. All pages shall be completely legible and oriented to correct reading view.
    2. Formats are acceptable only with written permission of the DEN Project Manager or required by the BIM PXP. For files in any of the following formats, the corresponding stringency will apply:
      - a. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.
        - 1) AutoCAD files shall be self-contained with no external x-references.
      - b. BIM files shall conform to the standards and formats outlined in the BIM PXP and DEN BIM DSM.
      - c. Portable Document Format (PDF) files shall be compatible with Adobe Acrobat 10.0, non-password-protected, and security-free.
      - d. Other files pre-approved by the DEN Project Manager.

#### **1.05 INITIAL SUBMITTAL**

- A. Each submittal document shall include a title block showing the following information:
  1. Date of submittal and revision dates.
  2. Contract title and number.
  3. The names of Contractor, subcontractor, supplier, manufacturer and when applicable, the seal and signature of an Engineer registered in the State of Colorado, for the involved discipline.
  4. Identification of product by either description, model number, style number or lot number.
  5. Subject identification by Contract Drawing or specification reference.
- B. On each submitted drawing, include a blank space on each sheet, three inches by four inches, in the lower right corner, just above the title block, in which the DEN Project Manager or the Designer of Record may indicate the action taken.
- C. Make submissions sufficiently in advance so that the DEN Project Manager Review may be completed not less than 30 days before Work represented by those submittals is scheduled to be performed.

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- D. Allow a minimum cycle of 30 days for review of each submittal by the DEN Project Manager.
- E. Accompany submittal documents with DEN transmittal form CM-30, Submittal, which shall contain the following information:
1. Contractor's name, address and telephone number.
  2. Submittal number and date.
  3. Contract title and number.
  4. Supplier's, manufacturer's, or subcontractor's name, address and telephone number.
  5. Identification of variations from Contract Documents.
  6. Contractor's stamp and signature certifying the Contractor's review.
  7. Identification of submittal:
    - a. If the submittal is being made on a General Condition or Special Condition, reference the General or Special Condition number the first two digits of the specification section shall be 00XXXX.
    - b. If the submittal is being made under a specification section, reference the specification number, paragraph number, and subparagraph number.
    - c. If the submittal is being made under a drawing, reference the drawing(s) number and sub-number.
- F. The Contractor shall describe, at the time of submission, variations from the Contract documents in writing, separate from the submittal document. If the DEN Project Manager approves any such variations, an appropriate Contract change order shall be issued, except that if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued. If a submission contains variations and the variation column is not marked on the transmittal form, it will not be considered for review and acceptance. Along with marking the transmittal as a variation, a description must be included which outlines all the differences including maintenance and utility services along with any cost savings from an item not containing the variation.
- G. Changes in accepted submittal documents will not be permitted unless those changes have been accepted, in writing, by the DEN Project Manager.
- H. The form and quality of submittal documents shall comply with Section 013325 "Shop and Working Drawings, Product Data, and Samples."

**1.06 SUPPLEMENTAL SUBMITTALS**

- A. Supplemental submittal documents initiated by the Contractor for consideration of corrective procedures shall contain sufficient data for review. Make supplemental submittals in the same manner as initial submittals with the appropriate primary transmittal referenced.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 CONTRACTOR'S REVIEW**

- A. The Contractor shall review all submittal documents, stamp, and sign as reviewed and approved as complying with Contract Documents prior to submission to the DEN Project Manager. Submittal documents that are submitted to the DEN Project Manager THAT

HAVE NOT BEEN REVIEWED BY THE CONTRACTOR will not be reviewed and will be returned to the Contractor. Contractor is responsible for any delays in the Project due to improperly reviewed, stamped, and signed submittals.

- B. The Owner review period will be limited to ten (10) business days from the time complete submittal documents have been submitted.
- C. The Contractor is responsible to obtain all approvals for all deferred submittals, shop drawings, and significant changes from the CCD Development Service Department.
- D. All submittals must delineate any deviation from the intended design and must submit request for substitution to address any significant variation. Refer to Title 4, Article 405 – Shop Drawings, Product Data, and Samples, and Article 406 – Substitution of Materials and Equipment of the General Contract Conditions, 2011 Edition.

### **3.02 REVIEW BY DEN PROJECT MANAGER**

- A. Submittal documents will be reviewed by the DEN Project Manager, the DEN Project Manager Team, and/or the DOR for conformance to requirements of the Contract Documents. Review of a separate item will not constitute review of an assembly in which the item functions. The DEN Project Manager will withhold approval of submittals that depend on other submittals not yet submitted. Review and acceptance will not relieve the Contractor from the Contractor's responsibility for accuracy of submittals, for compliance with all applicable regulations, for compliance with all codes and specifications, for conformity of submittal document to requirements of Contract Drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection and completion of the Contract in accordance with the Contract Drawings and specifications. Acceptance is not verification or certification that the submittals comply with all requirements nor does it guarantee approval by the Denver Building Department or Denver Fire Department.
- B. The City, the DOR, and/or the DEN Project Manager will review the submittal documents for general conformance with the Contract Documents and mark the Action Code, sign, and date the transmittal.
- C. The Action Codes have the following meanings:
  - 1. Accepted (ACC)
    - a. The submittal conforms to the respective requirements of the contract documents.
  - 2. Accepted as Noted (AAN)
    - a. The submittal conforms to the respective requirements of the Contract Documents after changes are made in accordance with reviewer's comments. AAN submittals do not need to be resubmitted.
  - 3. Revise and Resubmit (R&R)
    - a. The submittal is unacceptable and must be revised and resubmitted.
  - 4. Rejected (REJ)
    - a. The submittal is not approved and a new submittal in accordance with the Contract Documents must be prepared and submitted.
  - 5. For Information Only (FIO)
    - a. An item is received by the DEN Project Manager but is not reviewed.

### **3.03 CONTRACTOR'S RESPONSIBILITIES**

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- A. Coordinate each submittal document with the requirements of the Work. Place particular emphasis upon ensuring that each submittal of one trade is compatible with other submittals of that trade and submittals of other trades including producing as needed drawings showing the relationship of the Work of different trades.
- B. Contractor's responsibility for errors and omissions in submittal documents and associated calculations is not relieved by the DEN Project Manager's review, correction, and acceptance of submittals.
- C. Contractor's liability to the City, in case of variations in the submittal document from the requirements of the Contract Documents, is not relieved by the DEN Project Manager's review and acceptance of submittals containing variations unless the DEN Project Manager expressly approves the deviation in writing, in which the DEN Project Manager describes the variation.
- D. The Contractor shall maintain a file of all approved submittal documents at the work site. The complete file of approved submittal documents shall be turned over to the DEN Project Manager with the as-built documents at the end of the job.
- E. Schedule impact due to resubmittal requirements is the responsibility of the Contractor.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013300**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 013325****SHOP AND WORKING DRAWINGS, PRODUCT DATA, AND SAMPLES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparing and submitting shop and working drawings, product data, samples, and record documents required by other specifications Sections.
1. The Contractor shall submit all shop drawings, working drawings, product data, and samples, as defined in the General Conditions, to the DEN Project Manager in accordance with the requirements in the technical specifications. The DEN Project Manager will return one (1) copy of the shop drawings, working drawings and product data to the Contractor with a written transmittal.
- B. The Contractor shall not submit as shop drawings, copies or reproductions of drawings issued to the Contractor by DEN.
- C. Related Requirements
1. Section 013300 "Submittal Procedures
  2. Section 012510 "Substitutions"
  3. Section 017720 "Contract Closeout"

**1.03 SUBMITTALS**

- A. All submittals shall be delivered to the DEN Project Manager in electronic format. All submittals must be of a consistent format (all PDF). No combination of electronic file types will be allowed unless required by a specific specification section.
1. Acceptable electronic formats: Comply with the electronic file formats approved by DEN Building Information Modeling (BIM) Design Standards Manual If any of the files are in any of the formats listed below then the version of the software shall be no less than identified below:
    - a. Adobe Acrobat 8.0 or newer. All files shall be fully compatible with Adobe Acrobat 8.0.
    - b. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.
    - c. AutoDesk AutoCAD 2007 or newer. All files shall be fully compatible with AutoDesk AutoCAD 2007.
      - 1) AutoCAD files shall be self-contained with no external x-references.
    - d. BIM format outlined in the BIM Project Execution Plan (PXP)
    - e. Other files pre-approved by the DEN Project Manager.
  2. Adobe Acrobat Requirements:
    - a. Drawings shall have security set to "No Security." Commenting, printing, adding

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 013325 – SHOP AND WORKING DRAWINGS,**  
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- photos, form fields and document signing must be allowed.
- b. PDF submittals shall be one continuous file or Portfolio. No external links are allowed.
  - c. All individual components of submittals shall be bookmarked inside the PDF file.
  - d. All original documents shall be directly converted from the original electronic format to PDF. Scanning of files shall only be allowed by the DEN Project Manager when the original electronic information is not obtainable.
  - e. Failure to comply with these requirements will result in a return of file to the Contractor for immediate revision.
3. Electronic files submitted shall correspond with DEN File Control Numbering System available from the DEN Project Manager.
- B. Quantities**
1. One (1) electronic submittal in Unifier containing electronic files of each shop or working drawing.
  2. One (1) electronic submittal in Unifier containing electronic files of manufacturer's standard schematic drawings.
  3. One (1) electronic submittal in Unifier containing electronic files of manufacturer's calculations and manufacturer's standard data.
  4. One (1) electronic submittal in Unifier containing electronic files of manufacturer's printed installation, erection, application, and placing instructions.
  5. Nine (9) samples of each item specified in the various specification sections, unless otherwise specified.
  6. One electronic submittal in Unifier containing electronic files of inspection, test reports, and certificates of compliance.
  7. Note: If manufacturer's printed information is in color, all copies of submittals must be in color.
- C. Review:**
1. Submittal review comments by the DEN Project Manager will be in electronic form and incorporated into the electronic submittal file.
  2. Resubmittals of electronic documents shall modify the original electronic file with new information and include the DEN Project Manager's comments with appropriate responses and additional information.

**1.04 CHANGES**

- A. Changes in products for which shop or working drawings, product data or samples have been submitted will not be permitted unless those changes have been accepted and approved in writing by the Deputy Manager of Aviation as provided in Section 012510 "Substitutions."

**1.05 QUALITY CONTROL**

- A. Shop drawings and record documents shall be prepared to the standards of quality outlined in the specifications, DSM and BIM PXP, prepared and printed from Revit and checked in the spatial coordination format specified in the BIM PXP.
- B. Refer to DEN DFI DSM for other requirements that may be applicable to this Article.

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**PART 2 - PRODUCTS**

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**2.01 SHOP AND WORKING DRAWINGS**

- A. Prepare shop and working drawings in an electronic format that is current and approved by DEN to a scale large enough to easily depict and annotate each of the various items.
- B. Comply per other BIM requirements for Shop and Working Drawings as established in the DEN BIM DSM.
- C. Include the following as they apply to the subject:
  - 1. Contract title, work order, and number.
  - 2. Respective Contract drawing numbers.
  - 3. Applicable specification section numbers.
  - 4. Relation to adjacent structure or materials.
  - 5. Field dimensions clearly identified as such.
  - 6. Applicable standards such as ASTM or Federal Specification number, FAA, AASHTO, and pertinent authority specifications or standards.
  - 7. Identification of deviations from the Contract Drawings and specifications.
  - 8. Drawing name, number, and revision.
  - 9. Contractor's stamp, initialed or signed, certifying:
    - a. Verification of field measurements.
    - b. Review of submittals for compliance with Contract requirements.
    - c. Compatibility of the Work shown thereon with that of affected trades.
  - 10. Blank space on each sheet per Technical Specifications Section 013300 "Submittal Procedures."
- D. Drawings of equipment and other items that contain multiple parts shall include exploded views showing the relationship of parts and the description of the parts into the smallest units that may be purchased or serviced.
- E. Comply with all submittal requirements of Section 013300 "Submittal Procedures."

**2.02 PRODUCT DATA**

- A. Modify manufacturer's standard and/or schematic drawings to delete information that is not applicable to the Contract. Supplement standard information with additional information applicable to this Contract.
- B. Modify manufacturer's standard(s), diagrams, schedules, performance charts, illustrations, calculations, and other descriptive data to delete information that is not applicable to the Contract. Indicate dimensions, clearances, performance characteristics, and capacities. Include with the submittal electrical, plumbing, HVAC, and any other diagrams, as applicable.
- C. Modify erection, application, and placing instructions to delete information that is not applicable to the Contract or work order.
- D. Include the following:
  - 1. Contract title, work order, and number.

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**TECHNICAL SPECIFICATIONS  
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SECTION 013325 – SHOP AND WORKING DRAWINGS,  
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2. Respective Contract drawing numbers.
  3. Applicable Contract technical specification section numbers.
  4. Applicable standards such as ASTM or Federal Specification number, FAA, AASHTO and pertinent authority specifications or standards.
  5. Identification of deviations from the Contract Drawings and specifications.
  6. Contractor's stamp, initialed or signed, certifying:
    - a. Dimensional compatibility of the product with the space in which it is intended to be used.
    - b. Review of submittals for compliance with Contract requirements.
    - c. Compatibility of the product with other products with which it is to perform or which will be next to it.
    - d. The products electrical, plumbing, control and HVAC requirements conform to Contract Documents and the necessary utilities are provided for in the Contract Documents.
- E. Comply with all submittal requirements of Section 013300 "Submittal Procedures."

**2.03 SAMPLES**

- A. Submit samples of sizes and quantities to clearly illustrate full color range and functional characteristics of products and materials including attachment devices.
- B. Erect field samples and mockups at the work site as specified in specification Sections and at locations acceptable to the DEN Project Manager. All field samples shall be erected in a location that will be readily visible throughout the life of the Contract to allow comparison of the Work as it progresses to the field sample. Field samples and mockups may be incorporated into the Work at Contractor's risk if approved by DEN Project Manager.
- C. The Contractor shall verify, through appropriate inspections and tests, that the samples submitted meet the specifications and shall provide inspection and test data with the samples. The review and comments on the sample shall not relieve the Contractor of the Contractor's responsibility for completion of the Contract.
- D. Show the following information:
  1. Contract title and number.
  2. Respective Contract drawing numbers.
  3. Applicable technical specification section numbers.
  4. Applicable standards such as ASTM or Federal Specification number.
  5. Identification of deviations from the Contract Drawings and specifications
  6. Contractor's stamp, initialed or signed, certifying:
    - a. Dimensional compatibility of the product with the space in which it is intended to be used
    - b. Review of submittals for compliance with Contract requirements
    - c. Compatibility of the product with other products with which it is to perform or which will be next to it
  7. If multiple samples are submitted and the DEN Project Manager is requested to make a choice, each sample shall have a unique identification number attached to it so the returned transmittal can state the identification number of the accepted sample and the Contractor will know which one it is.

- E. Comply with all submittal requirements of Section 013300 "Submittal Procedures."

## **PART 3 - EXECUTION**

### **3.01 CONTRACTOR RESPONSIBILITIES**

- A. Verify field measurements, catalog numbers, and similar data.
- B. The Contractor shall not start work for which submittals are required until a transmittal has been received by the Contractor marked with the Action Code ACCEPTED or ACCEPTED AS NOTED by the DEN Project Manager.
- C. Before making submittals, ensure that the products will be available in the quantities and at the times required by the Contract.
- D. Submit final, corrected, electronic copies of Contract and shop and working drawings showing the Work as actually installed, placed, erected, and applied. Refer to Section 017720 "Contract Closeout."

### **3.02 REVIEW BY THE DEN PROJECT MANAGER**

- A. One (1) electronic copy of the marked-up shop and working drawing and one (1) electronic copy of the product data will be returned to the Contractor by the DEN Project Manager. Only the transmittal form appropriately marked with the Action Code and comments, if any, will be returned on sample submittals.
- B. Contractor's responsibility for errors and omissions in submittals for compatibility will not be reduced, waived or otherwise limited by the review and acceptance of submittals by the DEN Project Manager. Review and acceptance will not relieve the Contractor from the Contractor's responsibility for accuracy of shop drawings, for compliance with all codes and specifications, for conformity to requirements of Contract Drawings and specifications, for compatibility of products with contiguous products and the rest of the system, or for protection and completion of the Contract in accordance with the Contract Drawings and specifications. Approval is not verification or certification that the shop drawings comply with all requirements nor does it guarantee approval by the Denver Building Department or Denver Fire Department.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013325**

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**SECTION 013510**  
**CONSTRUCTION SAFETY**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. For Airside Construction Projects Related Specification Sections include:
  - 1. Section 011430 "Vehicle and Equipment Permitting".
  - 2. Section 011810 "Utilities Interface".

**1.02 SUMMARY**

- A. Work specified in this Section includes construction safety precautions and programs by the Contractor and the basis for reviews by the DEN Project Manager.
- B. For projects enrolled under a DEN Owner Controlled Insurance Program (OCIP) or Rolling Owner Controlled Insurance Program (ROCIP) reference the Contract Special Conditions and applicable DEN OCIP or ROCIP Safety Manual, included as Contract Documents, for additional safety requirements.
- C. For projects not enrolled under a DEN Owner Controlled Insurance Program (OCIP) or DEN Rolling Owner Controlled Insurance Program (ROCIP) reference the Contract Special Conditions for all safety requirements.

**1.03 RESPONSIBILITY**

- A. The Contractor is responsible for the health and safety of the Contractor's personnel, agents, subcontractors and their personnel, and other persons on the worksite, for the protection and preservation of the Work and all materials and equipment to be incorporated therein, and for the worksite and the area surrounding the worksite. The Contractor shall take all necessary and reasonable precautions and actions to protect all such persons and property.
- B. This Section shall be interpreted in its broadest sense for the protection of persons and property by the Contractor and no action or omission by the DEN Project Manager or the DEN Project Manager's authorized representatives shall relieve the Contractor of any of its obligations and duties hereunder.

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.
- B. Contractor's Site Specific Safety Plan:
  - 1. The Contractor's Site Specific Safety Plan shall be submitted and accepted as provided in the Contract prior to commencing any Work. If a Task Order or Change Order is issued where the Work is not covered by the Contractor's Site Specific Safety Plan, then a revision to the Safety Plan specific for the Work in the Task Order shall be resubmitted for approval. The Contractor's Safety Plan must meet requirements as

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outlined in the Contract. The Contractor should reference the applicable insurance requirements, including any Safety Manual and updates, and all applicable federal, state, and local laws and regulations. Additionally, for Airside Projects, the Contractor's Site Specific Safety Plan shall be developed according to the guidelines and requirements provided in the most current version of FAA Advisory (AC) 150/5370 "Operational Safety on Airports During Construction" and will describe how the Contractor will comply with the requirements of the Construction Safety and Phasing Plan (CSPP). The Site Specific Safety Plan shall cover the actions of not only the construction personnel and equipment, but the actions of inspection personnel and airport staff for the duration of construction activities.

2. No progress payment shall be approved until the Contractor's Site Specific Safety Plan has been accepted by the DEN Project Manager.
3. For projects enrolled in a ROCIP or OCIP, Contractor shall submit their Site Specific Safety Plan in accordance with the requirements and lead time outlined in the applicable R/OCIP Safety Manual and in accordance with Part 1.04.A of this Section.
4. For a project non enrolled in a ROCIP or OCIP, the Contractor shall submit the Contractor's Site Specific Safety Plan to the DEN Project Manager for review at least ten (10) calendar days before on-site construction begins. At a minimum, all applicable federal, state and local government requirements, and the following are to be included in the Contractor Site Specific Safety Plan:
5. The Contractor shall provide the following information for acceptance by the DEN Project Manager prior to the commencement of construction activities. The Site Specific Safety Plan must address all aspects listed below. If an item is not applicable, then this must be noted in the plan.
  - a. Name of the Contractor's safety representative.
  - b. If the Contractor is running multiple shifts or working more than (40) hours per week, the name of an assistant safety representative who can act in the absence of the site safety representative.
  - c. Twenty-four (24) hours per day emergency phone numbers of Contractor site management to be used in case of injury or accident. Provide at least four contacts.
  - d. How personnel will be handled who are unable to safely perform their duties, including how the Contractor will determine whether personnel are unable to safely perform duties. This may include the Contractor's disciplinary process and employee's physical capabilities to perform the work safely.
  - e. Injury and accident handling, including samples of the reporting form.
  - f. The type of safety training that will be provided to personnel to inform them of safe work procedures.
  - g. How daily audits and inspections will be performed to ensure compliance with the Contractor's Site Specific Safety Plan and current, applicable OSHA regulations.
  - h. Means of protecting employees working in trenches and excavations, including sloping and shielding.
    - 1) Soil classification will be considered as Type C when designing protective systems, unless the Contractor can prove to the satisfaction of DEN that the soil classification is otherwise. Soil classification change request shall be provided to the DEN Project Manager in writing. The decision of the DEN Project Manager will be provided to the Contractor in writing.
    - 2) The Contractor shall show how material shall be stored beside the excavation. Stored material shall include the excavated and backfilled material.
  - i. How and when equipment will be checked to see that it is safe, that all safety guards are in place, and that the equipment is being used for its designed purpose and within its rated capacity.

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- j. How and when all electric devices will be checked for proper grounding and insulation. Describe the methods that will be used for lock out tag out of electric systems that should not be energized.
- k. How trash and human organic waste will be disposed of.
- l. How snow and ice will be removed by the Contractor in the project area.
- m. How flammable materials will be stored and handled, and how any spills will be cleaned up and removed for disposal.
- n. What system will be used to prevent fires and, if fires do occur, who will be trained to fight them. In addition, what firefighting equipment will the Contractor have available and how will this equipment's condition be monitored.
- o. How materials will be received, unloaded, stored, moved, and disposed of.
- p. How personnel will be protected from falling when working at heights of 6 feet or more.
- q. How people working beneath the construction work will be protected.
- r. What will be done to protect personnel in case of severe weather.
- s. How adequate lighting will be provided and monitored.
- t. How air quality will be monitored to ensure that chemical exposures are below current, established OSHA Permissible Exposure Limits. How personnel will be protected if these limits are exceeded.
- u. How the safety of work platforms, man lifts, material lifts, ladders, shoring, scaffolding, etc., will be ensured relating to load capacity and the protection of personnel using or working around them.
- v. Where cranes will be set up and plans for each lift.
- w. The type of personal protective equipment that will be used to protect personnel from hazards. The minimum PPE requirements include hard hat, safety toe boots, safety glasses, proper hand protection, ANSI II vests for day work, and ANSI III vests and high visibility pants (gaiters may only be used airside) for night work.
- x. Procedures to ensure that welding and other hot work is performed safely.
  - 1) A hot work permit from the Denver Fire Department (DFD) will be required for all welding, soldering, cutting, and brazing and or other processes required by DFD on the project. Contractor will comply with all of the provisions in the permit.
- y. How compressed gases will be safely stored, handled, and used.
- z. Methods to ensure that personnel safely enter, work in, and exit confined spaces.
  - 1) All confined spaces on DEN property are considered permit required. A permit must be obtained from the DFD before Contractor personnel may enter a confined space. Contractors will comply with all provisions and requirements of this permit.
- aa. How the hazards of chemicals will be communicated to personnel, including the use of material safety data sheets and chemical labels.
- bb. Methods to ensure that forklifts and other powered industrial trucks are operated in a safe manner.
- cc. How an effective hearing conservation program will be used to protect personnel from high noise levels and prevent hearing loss.
- dd. How personnel will be protected from the effects of jet blast.
- ee. How hazards will be identified and corrected when reported.

**C. Safety submittal requirements**

- 1. For projects enrolled in a ROCIP or OCIP, Contractor shall submit all required safety submittals required by the Contract Documents, including the applicable ROCIP or OCIP Safety Manual including, but not limited to, high-hazard pre-task plans,

subcontractor pre-mobilization meetings, and incident reports. All Safety Submittals shall be submitted in accordance with Part 1.4.A of this Section unless otherwise modified by the Contract Documents. Contractor is responsible for reviewing the ROCIP or OCIP Safety Manual in its entirety and understanding full scope, timeline, and acceptance criteria outlined for the submittal requirements

**D. Additional safety submittals – ROCIP III**

1. The following is a representative list of submittals, other than the Site-Specific Safety Plan, that are required for relevant scopes of work or events covered under ROCIP III. This list is not all-inclusive and Contractor is responsible for reviewing the ROCIP III Safety Manual its entirety to determine if additional submittals are required for Contractor's scope of work. In addition, DEN may require additional safety pre-planning or pre-work meetings or information based on Contractor's scope of work and safety performance:
2. High-hazard Pre-Task Plans including:
  - a. Crane Operations
  - b. Elevated Work
  - c. Lock-Out Tag-Out
  - d. Trenching and Excavation
  - e. Confined Space
  - f. Hot Work
  - g. Traffic Control
  - h. Written Silica Exposure Control Program
  - i. Respiratory Protection Program
3. Preliminary Investigative Reports
4. Final Investigative Reports
5. Contractor's Monthly Safety Report

**E. Additional safety submittals – ROCIP IV**

1. The following is a representative list of submittals, other than the Site-Specific Safety Plan, that are required for relevant scopes of work or events covered under ROCIP IV. This list is not all-inclusive and Contractor is responsible for reviewing the ROCIP IV Safety Manual its entirety to determine if additional submittals are required for Contractor's scope of work. In addition, DEN may require additional safety pre-planning or pre-work meetings or information based on Contractor's scope of work and safety performance:
2. High-hazard Pre-Task Plans including:
  - a. Crane Operation
  - b. Elevated Work
  - c. Lock-Out Tag-Out
  - d. Utility Damage Prevention- Ground & Concrete Penetration
  - e. Trenching
  - f. Confined Space
  - g. Demolition
  - h. Hot Work
  - i. Traffic Control
  - j. Haul Routes
  - k. Silica Exposure and Slurry Control Program
  - l. Respiratory Protection Program

3. Subcontractor Safety Pre-Mobilization Documentation
4. Preliminary Investigative Reports
5. Final Investigative Reports
6. Contractor's Monthly Safety Report
7. Meeting Minutes and Attendance Log for Contractor's Supervisory Safety Meetings

**1.05 DEN PROJECT MANAGER'S REVIEW**

- A. Prior to the start of any work by contractor or subcontractor personnel, the Contractor shall provide the DEN Project Manager with a list of its personnel, subcontractor's personnel and other personnel the Contractor has requested to work at Denver International Airport, who have signified in writing that they have been briefed on, or have read and understand, the Contractor's Site Specific Safety Plan.

**1.06 AUDIT OF MANUAL COMPLIANCE**

- A. At its sole discretion, DEN may audit Contractor's submittals, including supporting documents that the contractor or its subcontractor is required to maintain or that would show compliance with the requirements of this Safety Manual. When documentation is requested, the Contractor must respond in the time outlined in the applicable ROCIP or OCIP Safety Manual, and where a timeline is not established, in no more than 7 days.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 IMPLEMENT CONTRACTOR'S SITE SPECIFIC SAFETY PLAN**

- A. Implement the approved Contractor's Site-Specific Safety Plan and other project safety plans as described in Part 1 of this Section, applicable Contract Safety Manual, all applicable regulations, Contract Documents, and in Section 011100 "Summary of Work."
- B. If the Project or an individual contractor or subcontractor experiences an OSHA DART or Total Recordable injury rate greater than 75 percent of the national average for all construction, the Contractor shall notify the DEN Project Manager and audit its safety procedures and submit a plan to reduce its rate(s).
- C. If at any time the OSHA DART or Total Recordable injury rates experienced by the Project or an individual contractor or subcontractor are 150 percent or more of the national average for construction, or exceeds \$0.50/labor hour, the Contractor shall notify the DEN Project Manager and immediately hire an independent safety professional at their own cost who shall audit the Contractor's procedures and operations and make a report of changes that the Contractor should implement to reduce the rate(s) including possible personnel changes.
  1. The report shall be submitted to the DEN Project Manager.
  2. The Contractor shall immediately begin implementing the recommendations of the independent safety professional.
  3. A weekly report shall be submitted by the Contractor to the DEN Project Manager on the status of the implementation of the recommendations.
  4. Failure to comply with these requirements is a basis to withhold a portion of progress payments or to terminate the Contract.

**3.02 SAFETY REQUIREMENTS FOR ALL CONSTRUCTION PROJECTS**

- A. For projects enrolled in a ROCIP or OCIP, Contractor will abide by all requirements specified in the Contract Documents, including the applicable ROCIP or OCIP Safety Manual. The applicable ROCIP or OCIP Safety Manual is incorporated in this Technical Specification for all enrolled projects.
- B. Contractor personnel, airport staff and field inspectors directly involved in DEN construction shall:
1. Be aware of the types of conditions, safety problems, and/or hazards identified each day at the airport. To ensure that all personnel are aware, daily meetings between management and supervisory personnel and their employees shall be scheduled prior to any work commencing on the shift.
  2. Inspect daily all work and/or storage areas for which the Contractor is responsible to be aware of current conditions.
  3. Promptly take all steps needed to remedy any unsafe or potentially unsafe condition. Coordinate with the DEN Project Manager to ensure immediate corrective action is undertaken.
- C. Housekeeping Requirements
1. Maintain the work site in a neat, orderly, and hazard-free manner in conformance with all federal, state, and local rules, codes, regulations, and orders, including all OSHA requirements, until Final Acceptance of the Work. Keep catwalks, underground structures, work site walks, sidewalks, roadways, and streets, along with public and private walkways adjacent to the work site, free from hazards caused by construction activities. All hard concrete, steel, wood, and finished walking surfaces shall be swept clean daily.
  2. Inspect those facilities regularly for hazardous conditions caused by construction activities. Maintain structures, grounds, storage areas and other areas of work site, including public and private properties immediately adjacent to work site, free from accumulations of waste materials caused by construction operations. Place waste materials in covered metal containers. Remove or secure loose material on open decks and on other exposed surfaces at the end of each workday or more often in a manner that will maintain the work site hazard free. Secure material in a manner that will prevent dislodgment by wind and other forces.
  3. Sprinkle waste materials with water or acceptable chemical palliative to prevent blowing of dust.
  4. Promptly empty waste containers when they become full and legally dispose of the contents at dumping areas off the City's property.
  5. Control the handling of waste materials. Do not permit materials to be dropped or thrown from structures.
  6. Immediately remove spillage of construction related materials from haul routes, work site, private property, public rights of way, or on the Denver International Airport site.
- D. Hazardous Material Controls
1. Store waste materials in properly labeled waste containers. This includes solid wastes, hazardous wastes, universal wastes, etc.
  2. Store volatile wastes in covered metal containers and remove those wastes from work site daily.
  3. Do not accumulate wastes that create hazardous conditions.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
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4. If volatile and noxious substances are being used in spaces that are not naturally ventilated adequately, provide artificial ventilation.
  5. Hazard controls shall conform to the applicable federal, state, and local rules and regulations.
  6. Provide appropriate waste receptacles in all areas in which employees are working. Waste receptacles shall be kept covered at all times. All materials on site shall be anchored and covered to prevent any objects from becoming wind-borne.
- E. Safe Access
1. Maintain the work site to permit access by other City contractors as required and to allow access by emergency personnel.
- F. Aviation safety and continuity of operations is a primary consideration during construction at DEN. Activities shall be planned and scheduled to minimize disruption of normal aircraft and operation activities, including minimizing impacts to vehicular traffic. If the clearances and restrictions described in this plan cannot be maintained while construction is underway, action will be taken by the Contractor to perform Work at night or during periods of minimal aircraft or operational activity.
1. During performance of this Contract, the airport runways, taxiways, taxi lanes, and aircraft parking aprons shall remain in use by aircraft to the maximum extent possible, consistent with continual safety. Aircraft use of areas near the Contractor's Work will be controlled to minimize disturbance to the Contractor's operation. However, AIRCRAFT HAVE THE RIGHT OF WAY AT ALL TIMES. The Contractor shall not allow employees, subcontractors, suppliers, or any unauthorized persons to enter or remain in any airport area that would be hazardous to persons or to aircraft operations.
  2. Before commencement of construction activity, the Contractor, through coordination with the DEN Project Manager and DEN Operations, shall give notice using the NOTAM system of construction on the airfield. In addition, a NOTAM shall be issued for the completion of construction on the airfield.
- G. The Contractor shall take all necessary steps and precautions to mitigate the impact of hazardous conditions as they may relate to the Work. Potentially hazardous conditions which may occur during airport construction include, but are not limited to, the following:
1. Trenches, holes, or excavations on or adjacent to any active runway, taxiway, taxi lane, apron, or related safety areas.
  2. Unmarked/unlighted holes or excavations on or adjacent to any active runway, taxiway, taxi lane, apron, or related safety areas.
  3. Mounds or piles of earth, construction material, temporary structures, or other objects on or in the vicinity of any active runway, taxiway, taxi lane, apron or related safety, approach, or departure areas.
  4. Pavement drop-offs that would cause, if crossed at normal operating speeds, damage to aircraft that normally use the airport. The maximum drop-off is 3 inches per the most current version of FAA AC 150/5300.
  5. Vehicles or equipment (whether operating or idle) on any active runway, taxiway, taxi lane, apron or related safety, approach, or departure areas.
  6. Vehicles, equipment, excavations, stockpiles, or other materials that could impinge upon NAVAID-critical areas and degrade or otherwise interfere with electronic NAVAIDS or interfere with visual NAVAIDS facilities.
  7. Unmarked utility, NAVAIDS, weather service, runway lighting, underground power, or signal cables that could be damaged during construction.

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8. Objects or activities anywhere on or in the vicinity of an airport which would be distracting, confusing, or alarming to pilots during aircraft operations.
  9. Unflagged/unlighted low visibility items such as tall cranes, backhoes, scrapers, dump trucks, rollers, compactors, dozers and the ilk, in the vicinity of an active runway, taxiway, taxi lane, apron or related safety, approach, or departure areas.
  10. Dirt, debris, or other transient accumulations that temporarily obscure pavement markings or pavement edges or derogate the visibility of runway or taxiway markings or lighting or of construction and maintenance areas.
  11. Trash or other materials with foreign object damage (FOD) potential, whether on runways, taxiways, taxi lanes, aprons or in related safety areas.
  12. Failure to control vehicle, human and large animal access to, and nonessential nonaeronautical activities on, open aircraft movement areas.
  13. Failure to maintain radio communication between construction vehicles and air traffic control or other on-field communications facilities.
  14. Construction activities or material which could hamper Aircraft Rescue and Fire Fighting (ARFF) vehicle access from ARFF stations to all parts of the runway/taxiway system, runway approach and departure areas, or aircraft parking locations.
  15. Inadequate fencing or other marking to separate construction areas from open aircraft operating areas.
  16. Bird attractions such as edibles (food scraps, etc.), trees, brush, other trash, grass/crop seeding, or ponded water on or near the airport.
- H. Construction Area Marking: Temporary lighting, barricades, flagging, and flashers are required as shown on the plans and per the most current version of FAA AC 150/5370 Chapter 2 Section 220.b.(1)(2) Flag lines, traffic cones, flashers, edge lights, and/or signs shall be used as necessary:
1. To clearly separate all construction from other parts of an air operations area
  2. To identify isolated hazards, such as open manholes, excavations, areas under repair, stockpiled material, waste areas, etc.
  3. Vehicle and pedestrian access routes used for airport construction shall be controlled to prevent any unauthorized entry of persons, vehicles, or animals.
  4. Vehicle parking areas for Contractor employees shall be designated in advance to minimize traffic in open/active aircraft movement areas.
- I. Cables and Utilities:
1. Special attention shall be given to preventing unscheduled interruption of utility services and facilities. The location of all cables and utilities shall be identified prior to construction activities. In addition to following regulatory utility locate requirements, Contractor shall provide a 3rd party SUE or utility designation firm to perform a ground penetrating radar (GPR) sweep in all areas that will be excavated, or the ground penetrated, prior to work.
  2. There shall be coordination among the Contractor, the DEN Project Manager, DEN Operations, the FAA, the National Weather Service, utility companies, and any other appropriate entity or organization. NAVAIDS, weather service facilities, electric cables, and other utilities must be fully protected during the entire construction time.
  3. Power, communication, and control cables leading to and from any FAA NAVAIDS, weather service, and other facilities will be marked in the field by the appropriate individuals as identified in Section 011810 "Utilities Interface" for the information of the Contractor before any work in their general vicinity is started. Thereafter, through the

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entire duration of construction, utilities shall be protected from any possible damage.

4. At the intersection of expansion joints and centerline lighting circuits on taxiways and runways, the electrical conduit may be within the 21" portion of the Portland cement concrete pavement. Coordination with the DEN Project Manager's representative and the DEN Electrical Department is required for both the scheduling of an outage and the removal of conductors while cutting the joint.
- J. Employee Identification:
1. The Contractor will be required to conform to the specific requirements as outlined in Section 011420 "Security Requirements and Sensitive Security Information (SSI)" of the Contract documents.
- K. Radio Communications:
1. The Contractor's construction superintendent and flagger personnel shall be required to coordinate directly with the DEN Project Manager or designated Representative. Only the DEN Project Manager or designated Representative shall monitor transceiver radios tuned to the frequency for communications with DEN Operations and B Tower Control. Radios shall be used to obtain the proper clearance concerning the movement of equipment, trucks, etc., on the airfield. Further, any unusual occurrences in the flight pattern of approaching or departing aircraft shall be acknowledged by all concerned so that operation of the airport and the construction work can be carried out safely.
- L. Haul Routes Crossing Active Aircraft Operation Areas:
1. The Contractor shall provide a minimum of one (1) broom truck to continuously clean the surface of the active taxiway, taxi lane or apron of any foreign object debris (FOD) or other objectionable debris that may result from hauling activities. Additional broom trucks may be required to expedite the cleanup process. Opening the taxiway, taxi lane, or apron to aircraft operations shall only be approved after a visual inspection of the pavement surface by the DEN Airfield Operations Manager.
  2. The Contractor shall not work within the minimum of the following: 160 ft. of the centerline of an active taxiway, 310 ft. of the centerline of an active runway, or the minimum requirements of the FOD or Safety Zone unless otherwise noted in the Contract Documents and as approved in writing by the DEN Project Manager.
  3. All construction equipment and vehicles shall be flagged for high daytime visibility and if appropriate, lighted for nighttime operations. Vehicles that are not marked and lighted shall be escorted by a vehicle that is equipped with appropriate marking and lighting devices. Marking and lighting shall be in conformance with FAA AC 150/5210, current edition, or as outlined in Section 011430 "Vehicle and Equipment Permitting" of the Contract Documents.
  4. All Contractor and Subcontractor employees must be aware of the types of safety problems and hazards associated with aircraft operations and construction activities. All haul truck drivers must have current route maps with them in their vehicles.
- M. Airside Definitions:
1. Approach Surface: A surface longitudinally centered on the extended runway centerline and extending outward and upward from either a runway threshold or 200 feet behind a threshold. This surface is needed to define where unobstructed airspace above the runway begins.
  2. Notice To Airmen (NOTAM): A notice to the flying public (airmen) through FAA's NOTAM system. Normally initiated by message to the nearest FAA Flight Service Station. Issuance of the NOTAM will be coordinated through the DEN Project

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Manager and DEN Operations.

3. Object Free Area: A two-dimensional ground area surrounding runways, taxiways, and taxi lanes that is clear of objects, except for objects whose location is fixed by function.
4. Safety Area (see current version of AC 150/5300): A defined surface adjacent to runways, taxiways and taxi lanes prepared or suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot or excursion from the paved surface. Each safety area must be cleared and graded and have no potentially hazardous ruts, humps, depressions or other surface variations. Each safety area must be drained by grading or storm sewers to prevent water accumulation. East safety area must be capable under dry conditions of supporting snow removal and aircraft rescue and firefighting equipment and or supporting the occasional passage of aircraft without causing any damage to the aircraft. No objects may be located in any safety area, except for objects that need to be located in a safety area because of their function. These objects must be constructed, to the extent practical, on frangibly mounted structures of the lowest practical height, with the frangible point no higher than three (3) inches above grade.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013510**

**SECTION 013516****ALTERATION PROJECT PROCEDURES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes special procedures for alteration work.

**1.03 DEFINITIONS**

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the DOR's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by DOR.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep existing items that are not to be removed or dismantled.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

**1.04 COORDINATION**

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and

scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.

1. Schedule construction operations in sequence required to obtain best Work results.
  2. Coordinate sequence of alteration work activities to accommodate the following:
    - a. Owner's continuing occupancy of portions of existing building.
    - b. Owner's partial occupancy of completed Work.
    - c. Other known work in progress.
    - d. Tests and inspections.
  3. Detail sequence of alteration work, with start and end dates.
  4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
  5. Use of elevator and stairs.
  6. Equipment Data: List gross loaded weight, axle-load distribution, and wheelbase dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project buildings and site. Some work is near circulation patterns and adjacent to restricted areas. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Access to restricted areas may not be obstructed. Plan and execute the Work accordingly.

#### **1.05 PROJECT MEETINGS FOR ALTERATION WORK**

- A. Preliminary Meeting for Alteration Work: Before starting alteration work, DEN Project Manager will conduct meeting at Project Site.
1. Attendees: In addition to representatives of City, DEN Project Manager, DOR, and Contractor, a testing service representative and specialists shall be represented at the meeting.
  2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
    - a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Fire-prevention plan.
    - c. Governing regulations.
    - d. Areas where existing construction is to remain and the required protection.
    - e. Hauling routes.
    - f. Sequence of alteration work operations.
    - g. Storage, protection, and accounting for salvaged and specially fabricated items.
    - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
    - i. Qualifications of personnel assigned to alteration work and assigned duties.
    - j. Requirements for extent and quality of work, tolerances, and required clearances.
    - k. Embedded work such as flashings and lintels, special details, collection of waste,

protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from meeting.
- B. Coordination Meetings: Conduct coordination meetings specifically for alteration work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation meeting.
1. Attendees: In addition to representatives of the City, DEN Project Manager, DOR, and Contractor, each specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of alteration work activities shall be represented at these meetings. All participants at meeting shall be familiar with Project and authorized to conclude matters relating to alteration work.
  2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of alteration work. Include topics for discussion as appropriate to status of Project.
    - a. Alteration Work Subschedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
    - b. Schedule Updating: Revise Contractor's Alteration Work Subschedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
    - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Meeting for Alteration Work" Paragraph in this article and the following:
      - 1) Interface requirements of alteration work with other Project Work.
      - 2) Status of submittals for alteration work.
      - 3) Access to alteration work locations.
      - 4) Effectiveness of fire-prevention plan.
      - 5) Quality and work standards of alteration work.
      - 6) Change Orders for alteration work.
  3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

## **1.06 MATERIALS OWNERSHIP**

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to City that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain the City's property.
1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to where directed at Project site.

## **1.07 INFORMATIONAL SUBMITTALS**

- A. Alteration Work Subschedule:
1. Submit alteration work subschedule within 30 days of date established for commencement of alteration work.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and

site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.

- C. Alteration Work Program: Submit 30 days before work begins.
- D. Fire-Prevention Plan: Submit 30 days before work begins.

### **1.08 QUALITY ASSURANCE**

- A. Specialist Qualifications: An experienced firm regularly engaged in specialty work similar in nature, materials, design, and extent to alteration work as specified in each Section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.
  - 1. Field Supervisor Qualifications: Full-time supervisors experienced in specialty work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on-site when specialty work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
    - a. Construct new mockups of required work whenever a supervisor is replaced.
- B. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.
- C. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.
  - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
  - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- D. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with City's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
- E. Safety and Health Standard: Comply with the current version of the ANSI/ASSE Safety and Health Program Requirements for Demolition Operations

### **1.09 STORAGE AND HANDLING OF SALVAGED MATERIALS**

- A. Salvaged Materials:
  - 1. Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
  - 2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
  - 3. Store items in a secure area until delivery to specified location.
  - 4. Transport items to the designated storage area indicated on Drawings.

5. Protect items from damage during transport and storage.
- B. Salvaged Materials for Reinstallation:
1. Repair and clean items for reuse as indicated.
  2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.
- C. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by DOR, items may be dismantled and taken to an approved, suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.
- D. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
  2. Secure stored materials to protect from theft.
  3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5°F or more above the dew point.
- E. Storage Space:
1. DEN Project Manager will arrange for limited on-site locations for free storage of salvaged material. This storage space does not include security and climate control for stored material.
  2. Arrange for off-site locations for storage and protection of salvaged material that cannot be stored and protected on-site.

#### **1.10 FIELD CONDITIONS**

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs and preconstruction videotapes, as required by the DEN PM.
1. Comply with requirements specified in Section 013233 "Photographic Documentation."
- B. Discrepancies: Notify DEN Project Manager of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.
- C. DEN's Removals: Before beginning alteration work, verify in correspondence with DEN Project Manager that the Owner facilities requiring removal have been removed.
- D. Size Limitations in Existing Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PROTECTION**

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
1. Use only proven protection methods, appropriate to each area and surface being protected.
  2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
  3. Erect temporary barriers to form and maintain fire-egress routes.
  4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
  5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
  6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
  7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
  8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
  2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
1. Notify DEN Project Manager, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
  2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
  3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify DEN Project Manager immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.
1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by

sand or other materials resulting from alteration work.

2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- F. Existing Roofing: Prior to the start of work in an area, install roofing protection as indicated on drawings.

### **3.02 PROTECTION FROM FIRE**

- A. General: Follow fire-prevention plan and the following:
1. Comply with NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations requirements unless otherwise indicated. Perform duties titled "City's Responsibility for Fire Protection."
  2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
    - a. If combustible material cannot be removed, provide fire blankets to cover such materials.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:
1. Use of open-flame equipment is not permitted.
  2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
  3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
  4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
  5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
  6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
    - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
    - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
    - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
    - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
    - e. Maintain fire-watch personnel at each area of Project site until 60 minutes after conclusion of daily work.
- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire

risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire extinguisher and blanket use.

- D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.
  - 1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

### **3.03 PROTECTION DURING APPLICATION OF CHEMICALS**

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off City's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

### **3.04 GENERAL ALTERATION WORK**

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 013233 "Photographic Documentation."
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify DEN Project Manager of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
  - 1. Do not proceed with the work in question until directed by DEN Project Manager.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 013516 – ALTERATION PROJECT PROCEDURES**

**DENVER INTERNATIONAL AIRPORT  
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**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 013516**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 013516 – ALTERATION PROJECT PROCEDURES**

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**SECTION 014100**  
**REGULATORY REQUIREMENTS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section identifies primary compliance with the State's and the City and County of Denver's regulatory requirements including but not limited to:
1. City and County of Denver applicable agencies, including but not limited to its Department of Aviation, Community Planning and Development (including Building Department), Department of Transportation and Infrastructure, and Mayor's Executive Orders.
  2. Colorado Department of Public Health and Environment; and
  3. The standards that govern design and construction projects at Denver International Airport; and
  4. Any other regulatory requirements that govern or apply to the specific work.
- B. Construction shall be based on the latest edition of the referenced codes including additions and revisions thereto that are in effect at the time of Project bidding or Task Order pricing or GMP established whichever is latest, and as specifically related.

**1.03 RELATED SECTIONS**

- A. None.

**1.04 BUILDING CODE**

- A. All design and construction work shall be governed by the Building Code for the City and County of Denver, latest edition. This is based upon the International Building Code of the International Code Council with Denver Amendments to this code. Appendix N of the Denver Amendments addresses Construction of Airport Buildings and Structures.
1. This Contract shall be based on the most current published version of the ICC series as Amended by The City and County of Denver.

**1.05 DENVER BUILDING DEPARTMENT**

- A. For review and approval of all construction documents for compliance to the Denver building code:

Community Planning and Development  
201 W. Colfax Ave., Dept 205  
Denver, CO 80202  
Telephone: 720-865-2790

**1.06 DENVER FIRE DEPARTMENT**

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**TECHNICAL SPECIFICATIONS**  
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**SECTION 014100 – REGULATORY REQUIREMENTS****DENVER INTERNATIONAL AIRPORT**  
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- A. For review and approval of plans for compliance with the Denver Fire Department's requirements as they apply to the Denver International Airport:
- Denver Fire Department  
725 West Colfax Avenue  
Denver, CO 80204  
Telephone: 720-913-3474
- B. The Contractor is advised that the Denver Fire Department – Fire Prevention Bureau requires permitting for the following activities as they apply to the scope of work. The Contractor is responsible for obtaining the appropriate permits necessary to complete the work including, but not limited to, the work listed below. All costs associated with this permitting and policy compliance shall be the responsibility of the Contractor. The policies all reference the International Fire Code (IFC).
1. "Hot work", which is defined as the operation of any equipment or tool that creates sparks, hot slag, or radiant or convective heat as a result of the work. This includes, but is not limited to, welding, cutting, brazing, or soldering.
  2. Use and storage of compressed gas for both temporary storage and permanent facility installation. This includes, but is not limited to, flammable gas (excluding propane-LPG), oxidizer (including oxygen), and inert and/or simple asphyxiates.
  3. Tank installation, which includes aboveground storage tanks (AST) and underground storage tanks (UST) for both temporary tanks and permanent facility installations.
  4. Access to and work within areas that are designated as confined spaces.
- C. In addition to the above permits, the Denver Fire Department may require other permits that are associated with the specific work in the Contract Documents. Policies provided by the Denver Fire Department are meant to provide basic information for the most common conditions and situations. In any given occupancy, many other Uniform Fire Code requirements may be enforced. These should be addressed with the Denver Fire Department before construction begins and during construction with premise inspection(s).
1. The Fire Prevention Bureau web site is [denfpb@denvergov.org](mailto:denfpb@denvergov.org)

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PERMITS AND CERTIFICATIONS**

- A. The Contractor shall maintain records on site of all permits acquired by federal, state, and local agencies. Posting of permits shall conform to requirements of the respective agencies.
- B. At the completion of any inspection by other agencies, the Contractor shall forward copies of the status of the inspection and copies of any approved or "signed-off" inspections by the respective agencies to the DEN Project Manager.
- C. At the time of request for Substantial Completion, the Contractor shall forward to the DEN Project Manager all permits approved by the respective agencies.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 014100 – REGULATORY REQUIREMENTS**

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**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014100**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 014100 – REGULATORY REQUIREMENTS**

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**SECTION 014210****REFERENCED MATERIAL****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 REFERENCED MATERIAL**

- A. City and County of Denver, Department of Aviation, Standard Specification for Construction, General Contract Conditions
- B. The following documents may be available for examination at the Owner's offices unless otherwise noted. The referenced material and documents are not part of the Contract Documents unless otherwise specified.
1. Environmental Impact Statement (EIS).
  2. Geotechnical Reports:
    - a. Borings, other field and laboratory explorations, and investigations have been made to indicate subsurface materials at particular locations. Explorations and investigations conducted by designers and their subconsultants are solely for the purpose of study and design.
    - b. The subsurface exploration and investigation information is presented or made available to indicate some of the conditions that may be encountered during construction and is offered as supplementary information only. Geotechnical information presented in the referenced material represents the opinion of soils consultants as to the character of the materials encountered. Subsurface information was directly obtained only at the specified location and necessarily indicates subsurface conditions only at the respective plan location, depths penetrated and only at the time of the exploration.
    - c. Neither the City nor the Designers assume any responsibility whatever in respect to the sufficiency or accuracy of borings made, or of the logs of test borings, or of other investigations, or of the interpretations made thereof, and there is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations are representative of those existing throughout such area, or any part thereof, or that unforeseen developments may not occur. It is expressly understood that the making of deductions, interpretations, and conclusions from all of the accessible factual information, including the nature of the materials to be excavated, the difficulties of doing other work affected by the geology, groundwater elevations and other subsurface conditions at the site of the Work are the Contractor's sole responsibility.
    - d. Information derived from inspection of logs of borings, topographic maps, technical memorandum, reports, or plans showing information of the subsurface of site conditions will not relieve the Contractor from any risk or from properly examining the site and making such additional investigations as the Contractor may elect or from properly fulfilling all the terms of the Contract Documents.
  3. Available Conceptual Utility and Drainage Reports.
  4. DEN Digital Facilities and Infrastructure (DFI) Design Standards Manual (DSM)
  5. Woolpert, Inc. Report - "A Low Distortion Projection for Denver International Airport

(DEN)", dated 12/10/2010.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014210**

## SECTION 014220

### ABBREVIATIONS AND SYMBOLS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Edit and/or insert items in list below as required for Project.

##### 1.02 REFERENCE LIST

- A. Documents published by the following agencies may be referenced within these Contract Documents to define the quality of materials, equipment, workmanship, and other features of Work. Unless otherwise stated, the reference documents shall be of the latest edition as of the date of the Advertisement for Bids.
- B. Wherever used in the Contract Documents, the following abbreviations will have the meanings listed:

<b>Abbreviation</b>	<b>Definition</b>
AALA	American Association of Laboratory Accreditation
AAN	American Association of Nurserymen
AAO	Affirmative Action Officer
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AFI	Air-Filter Institute
AGTS	Automated Ground Transportation System
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
APEN	Air Pollution Emission Notes
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWPA	American Wood Preserver's Association
AWS	American Welding Society
AWWA	American Water Works Association
BID	Building Inspection Division, Department of Public Works
BIM	Building Information Modeling

**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 014220 - ABBREVIATIONS AND SYMBOLS**

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<b>Abbreviation</b>	<b>Definition</b>
CAR	Corrective Action Report
CCD	City and County of Denver
CCR	Contractor Change Request
CCRL	Cement Concrete Reference Laboratory
CD	Change Directive
CDOH	Colorado Department of Highways or Colorado Department of Health
CDOT	Colorado Department of Transportation
CMEC	Concrete Materials Engineering Council
CN	Change Notice
CO	Change Order
COE	Corps of Engineers
CPM	Critical Path Method
CR	Change Request
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DEN	Denver International Airport
DFD	Denver Fire Department
DOT	United States Department of Transportation
DOR	Designer of Record
DWB	Denver Water Board
EEO	Equal Employment Officer or Equal Employment Opportunity
EIA	Electronics Industry Association
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FM	Factory Mutual Association
FS	Federal Specifications (U.S. General Services Administration)
GCC	General Contract Conditions
GIS	Geographic Information Systems
GMP -	Guaranteed Maximum Price
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code (published by ICC)
IBR	Institute of Boiler and Radiator Manufacturer's
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMC	International Mechanical Code (published by ICBO)
IPC	International Plumbing Code (published by ICBO)
ISA	Instrument Society of America
ITA	Independent Testing Agency
MIL	Military Specifications (Naval Publications and Forms Center)
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
MUTCD	Manual of Uniform Traffic Control Devices
NAAB	National Association of Air Balance
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards (now called National Institute of Standards and Technology)
NEC	National Electric Code (NFPA 70)
NECA	National Electric Contractors Association
NEMA	National Electrical Manufacturer's Association

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<b>Abbreviation</b>	<b>Definition</b>
NESC	National Electrical Safety Code
NFC	National Fire Code (as published by NFPA)
NFPA	National Fire Protection Association
NICET	National Institute for the Certification of Engineering Technologies
NIST	National Institute of Standards and Technology
NGS	National Geological Survey
NLMA	National Lumber Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NRMCA	National Ready Mix Concrete Association
NTP	Notice to Proceed
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDM	Precedent Diagram Method
PS	Product Standard of NIST (U.S. Department of Commerce)
PM	Project Manager
PMT	Project Management Team
PXP	Project Execution Plan
QA	Quality Assurance
QC	Quality Control
RFI	Request for Information
RTD	Regional Transportation District
SC	Special Contract Condition
SDI	Steel Door Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPWC	Standard Specifications for Public Works Construction
TCP	Traffic Control Plan
TSA	Transportation Security Administration
UL	Underwriters Laboratories, Inc.
USC	United States Code
WBS	Work Breakdown Schedule

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014220**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
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**SECTION 014225****REFERENCE STANDARDS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section contains a summary of industry-accepted and recognized standards published by trade associations, government, and institutional organizations that are referred to in the various Sections of these specifications or elsewhere in the Contract Documents.
- B. Standards listed herein are included in the Contract Documents by this reference and become a part of the Contract Documents to the same extent as though included in their entirety unless specific limitations are noted in the individual specifications Sections.
- C. Listings of reference standards include name and address of the organization publishing the standard, and the full name and designator of each of the standards referenced herein.
- D. If a publication date or edition number is listed with the reference standard, that publication date or edition number shall apply. Otherwise, the publication date or edition number in effect at the Contract date shall apply.
- E. Inclusion of reference standards herein does not make the DEN Project Manager an agent of the publishing agency, nor does it obligate the DEN Project Manager to perform inspections required by or to enforce rules or regulations contained in the reference standards.

**1.03 SCHEDULE OF REFERENCE STANDARDS**

- A. American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, NW, Suite 249, Washington, DC 20090:
1. AASHTO M 36–Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
  2. AASHTO M216–Standard Specification for Lime for Soil Stabilization.
  3. AASHTO T26–Standard Method of Test for Water to be Used in Concrete.
  4. AASHTO T84–Specific Gravity and Absorption of Fine Aggregate.
  5. AASHTO T85–Specific Gravity and Absorption of Coarse Aggregate.
  6. AASHTO T103–Soundness of Aggregates by Freezing and Thawing
  7. AASHTO T219–Standard Methods of Testing Lime for Chemical Constituents and Particle Sizes.
- B. American Concrete Institute (ACI) 38800 Country Club Drive, Farmington Hills, MI 48331
1. ACI 211.1–Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
  2. ACI 301–Specifications for Structural Concrete for Buildings.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
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3. ACI 304–Recommended Practices for Measuring, Mixing, Transporting and Placing Concrete.
  4. ACI 304.2R–Placing Concrete by Pumping Methods.
  5. ACI 305R–Hot Weather Concreting.
  6. ACI 306R–Cold Weather Concreting.
  7. ACI 318–Building Codes Requirements for Structural Concrete
    - a. Reference to ACI 318 may be limited to more stringent requirements of local building code.
- C. American Society for Testing and Materials (ASTM), International 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428:
1. ASTM A 27–Mild to Medium Strength Carbon - Steel Casting for General Application.
  2. ASTM A 36–Structural Steel.
  3. ASTM A 47–Malleable Iron Castings.
  4. ASTM A 82—Specification for Steel Wire, Plain, for Concrete Reinforcement: Replaced by A1064
  5. ASTM A 123–Hot-dip Galvanizing.
  6. ASTM A 184–Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
  7. ASTM A 185—Specifications for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement: Replaced by A1064
  8. ASTM A 283–Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.
  9. ASTM A 615–Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  10. ASTM A 706–Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
  11. ASTM C 25–Method for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime.
  12. ASTM C29–Unit Weight and Voids in Aggregate
  13. ASTM C 31–Methods of Making and Curing Concrete Test Specimens in the Field.
  14. ASTM C 33–Specification for Concrete Aggregates.
  15. ASTM C 39–Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  16. ASTM C 42–Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  17. ASTM C 76–Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  18. ASTM C 88–Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
  19. ASTM C 94–Specification for Ready Mixed Concrete.
  20. ASTM C 109–Compressive Strength of Hydraulic Cement Mortars
  21. ASTM C 110–Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone.

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**TECHNICAL SPECIFICATIONS**  
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22. ASTM C 117–Materials Finer than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing.
23. ASTM C 131–Resistance of Abrasions of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
24. ASTM C 136–Method for Sieve Analysis of Fine and Coarse Aggregates.
25. ASTM C 138–Unit Weight, Yield, and Air Content of Concrete.
26. ASTM C 143–Test Method for Slump of Hydraulic – Cement Concrete
27. ASTM C 150–Specification for Portland Cement
28. ASTM C 171–Specification for Sheet Material for Curing Concrete.
29. ASTM C 172–Method of Sampling Fresh Concrete.
30. ASTM C 173–Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
31. ASTM C 231–Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
32. ASTM C 260–Specification for Air Entraining Admixture for Concrete.
33. ASTM C 309–Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
34. ASTM C 443–Joints for Concrete Pipe and Manholes, using Rubber Gasket
35. ASTM C 494–Specification for Chemical Admixtures for Concrete.
36. ASTM C 595–Blend Hydraulic Cements.
37. ASTM C 618–Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete
38. ASTM C 655–Reinforced Concrete D Load Culvert, Storm Drain, and Sewer Pipe.
39. ASTM C 789—Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers: Replaced by C1433
40. ASTM C 803–Test Method for Penetration Resistance of Hardened Concrete.
41. ASTM C 805–Test Method for Rebound Number of Hardened Concrete.
42. ASTM C 977–Specification for Quicklime and Hydrated Lime for Soil Stabilization.
43. ASTM D 75–Sampling Aggregate.
44. ASTM D 422–Test Method for Particle Size Analysis of Soils.
45. ASTM D 516-88–Standard Test Method for Sulfate Ions in Water.
46. ASTM D 693—Crushed Stone, Crushed Slag and Crushed Gravel for Dryer Water-Bound Macadam Base Courses and Bituminous Macadam Base and Surface Courses of Pavements: Withdrawn
47. ASTM D 698–Laboratory Compaction Characteristics of Soil using Standard Effort
48. ASTM D 751–Test Method for Coated Fabrics
49. ASTM D 1556–Test Method for Density of Soil in Place by the Sand-Cone Method.
50. ASTM D 1557–Laboratory Compaction Characteristics of Soil using Modified Effort
51. ASTM D 1682—Ultraviolet Resistance Grab Tensile Strength Grab Tensile Elongation Toughness: Replaced by D5034 and D5035
52. ASTM D 1751–Specification for Preformed Expansion Joint Fillers for Concrete

**TECHNICAL SPECIFICATIONS**  
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**SECTION 014225 – REFERENCE STANDARDS**

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Paving and Structural Construction.

53. ASTM D 1752–Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
  54. ASTM D 2167–Test Method for Density of Soil in Place by the Rubber-Balloon Method.
  55. ASTM D 2216–Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures.
  56. ASTM D -79 (2011) Hydroxypropyl Methylcellulose
  57. ASTM D 2419–Sand Equivalent Value of Soils and Fine Aggregate.
  58. ASTM D 2487–Test Method for Classification of Soils for Engineering Purposes.
  59. ASTM D 2922—Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Method: Replaced by D6938
  60. ASTM D 3017—Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth): Replaced by D6938
  61. ASTM D 3665–Random Sampling of Paving Materials.
  62. ASTM D 4253–Test Method for Maximum Index Density of Soils Using Vibratory Table.
  63. ASTM D 4318–Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  64. ASTM D 4397–Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications.
  65. ASTM D 4546–Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils.
  66. ASTM E 329–Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
  67. ASTM F 477–Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
  68. ASTM F 758–Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage.
- D. American Welding Society (AWS), 550 NW LeJeune Road, Miami, FL 33135 AWS Code for Welding in Building Construction (Structural Welding Code).
- E. Concrete Reinforcing Steel Institute (CRSI) 933 N. Plum Grove Road, Schaumburg, IL 60195, (312) 490-1700:
1. Manual of Standard Practice.
- F. Colorado Department of Transportation (CDOT) Division of Administration, Office of Bid Plans, 4201 E. Arkansas Avenue, Denver, CO 80222:
1. Standard Specifications for Road and Bridge Construction (latest edition) Colorado Standard Plans, M&S Standards.
- G. Federal Highway Administration (FHWA) Superintendent of Documents, US Government Printing Office, Washington DC, 20402:
1. Manual of Uniform Traffic Control Devices (latest edition).

**PART 2 - PRODUCTS (NOT USED)**

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**TECHNICAL SPECIFICATIONS  
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**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014225**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
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**SECTION 014230****DEFINITIONS AND CONVENTIONS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This Section contains a list of definitions of words or phrases and grammatical or contextual conventions commonly used in these Contract Documents.

**1.03 DEFINITIONS**

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. Alphabetical Listing of Definitions:
1. As indicated: Shown on the drawings by graphic indication, notes, or schedules, or written in the specifications or elsewhere in the Contract Documents.
  2. As directed, as approved, as requested: Unless otherwise indicated, these terms imply "by the DEN Project Manager" and require that an instruction be obtained by the Contractor from the DEN Project Manager.
  3. Concealed: Embedded in masonry, concrete, or other construction; installed in furred spaces; within double partitions or hung ceilings; in trenches; in crawl spaces or in enclosures.
  4. Ensure: To make certain in a way that eliminates the possibility of error.
  5. Exposed: Not installed underground or "concealed" as defined above.
  6. Furnish or Provide: To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
  7. Indicated, Shown, or Noted: As depicted on drawings or specifications.
  8. Install: To erect, mount and connect complete with related accessories.
  9. Or equal, or approved equal: Refers to products which, in the opinion of the DEN Project Manager, are similar in all respects to products specified by proprietary brand name. Refer to Section 012510 "Substitutions" for procedures for submittal of proposed substitutions.
  10. Rework: To repair existing items or work required to be removed and replaced in order to accomplish the Work in accordance with the Contract Documents.
  11. Related Work: Includes, but not necessarily limited to, mentioned work associated with, or affected by, the Work specified.
  12. Reviewed, Satisfactory, Accepted, or Directed: Assumes by or to the DEN Project Manager.
  13. Similar, or Equal: Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
  14. Supply: To purchase, procure, acquire and deliver complete with related accessories.

15. Unless Otherwise Indicated and Unless Otherwise Noted: General note to perform work as indicated or shown on drawings or in specifications unless specifically directed otherwise elsewhere in the Contract Documents; may be abbreviated "U.O.N.", "U.O.I.", or "U.N.O."

C. BIM Model Definitions:

1. Building Information Model (BIM): BIM is a digital representation of the physical and functional characteristics of the Project and is referred as a Model(s), which term may be used to describe a Model Element, a single Model or technology used to create the Model.
2. Design Model: A Model that has reached the stage of completion that would customarily be expressed by an architect or engineer in two-dimensional Construction Documents.
3. Construction Model: The equivalent of shop drawing and other information useful to construction. A model that consists of data imported from a "Design Model or", if none exist, from a designer's "Construction Document".
4. Federated Model: Distinct component models "linked" together in such a manner that the linked data sources so not lose the indent or integrity by being so linked.
5. Level of Development (LoD): LoD describes the level of completeness to which a Model Element is developed.
6. Model Element: Is a portion of the BIM representing a component system or assembly within a building or building site.
7. Model Element Author: The party responsible for developing the content of a specific Model Element to the LoD for a particular phase of the Project.

#### **1.04 BIM REFERENCE STANDARDS**

- A. Refer to the DEN BIM Design Standard Manual (DSM) for the proposed minimum requirements of the BIM Execution Plan. The execution plan shall be further developed jointly with DEN and the Contractor to specifically address the administrative steps necessary to provide comprehensive BIM system before during and after construction.

#### **1.05 CONVENTIONS**

A. Specifications Format:

1. In order to standardize the location of information in the Contract Documents, the specifications generally are organized in one or more of the following formats:
  - a. The "MASTERFORMAT" 2011 Edition published by the Construction Specifications Institute.
  - b. The Standard Specifications for Road and Bridge Construction published by CDOT.
  - c. The alphanumeric system as published by the FAA.

B. Organization of Drawings and Specifications:

1. Organization of the specifications into divisions and sections, and arrangement or numbering of drawings is intended solely for the convenience of the Contractor in the Contractor's responsibilities to divide the Work among subcontractors or to establish the extent of work to be performed by any trade.
2. Neither the City nor the DEN Project Manager assume any liability arising out of jurisdictional issues or claims advanced by trade organizations or other interested parties based on the arrangement or organization of drawings or specifications.

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**TECHNICAL SPECIFICATIONS**  
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**SECTION 014230 – DEFINITIONS AND CONVENTIONS**

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- C. Gender and Number:
1. For convenience and uniformity, parties to the Contract, including the City, Contractor, and DEN Project Manager, and their subcontractors, suppliers, installers, consultants or other interested parties are referred to throughout the Contract Documents as if masculine in gender and singular in number. Such reference is not intended to limit the meaning of the Contract Documents to the masculine gender or singular number.
- D. Singular vs. Plural:
1. Materials, products, equipment, or other items of work referred to in the singular shall be construed as plural where applicable by the intent of the Contract Documents and shall not limit quantities to be provided by the Contractor.
- E. Imperative Mood:
1. Specifications and notes on the drawings or elsewhere in the Contract Documents are generally written in the imperative mood as instructions to the Contractor, whether the Contractor is specifically addressed or not.
- F. References to Subcontractors or Trades
1. References to subcontractors, trades or other entities, which are not parties to the Contract, shall be construed as meaning the Contractor whose responsibility it shall be to divide the Work among subcontractors or trades. Such references are used as a matter of convention, and are not intended to preclude or direct the Contractor's responsibility to divide the Work.
- G. Abbreviations
1. A list of abbreviations used in the Contract Documents is included in Technical Specifications Section 014220 "Abbreviations and Symbols"; an abridged list of abbreviations used on the drawings is included with the drawings.
  2. Abbreviations are believed to be those in general use in the construction industry. Contact the DEN Project Manager for clarification of abbreviations for which the meaning is not clear.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014230**

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**SECTION 014320****DEN QUALITY ASSURANCE FOR FAA FUNDED PROJECTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Refer to Title 17 – Inspection and Defects in the General Contract Conditions, 2011 Edition.
- C. ASTM standard practices and specifications testing including, but not limited to, the following:
  - 1. ASTM C 1077: Standard Practices for Laboratory Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
  - 2. ASTM D 3666: Road & Paving Materials
  - 3. ASTM D 3740: Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
  - 4. ASTM E 329: Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction
  - 5. ASTM E 543: Determining the Qualifications of Nondestructive Testing Agencies.
- D. Other:
  - 1. Standard testing practices for other disciplines.

**1.02 SUMMARY**

- A. This Section identifies Denver International Airport (DEN) inspection activities to be performed by inspectors employed by DEN and working under the direction of the DEN Project Manager.

**1.03 QUALITY ASSURANCE**

- A. Inspection and tests, conducted by persons or agencies, including DEN, other than the Contractor, shall not in any way relieve the Contractor of the Contractor's responsibility and obligation to meet all requirements of Contract Documents and the referenced standards.
- B. The inspection and approval of Work by other agencies above does not constitute inspection or acceptance of Work required by DEN. The Contract Documents may contain requirements more stringent than Denver Building Inspection Division or other code agency requirements. The City will perform all acceptance testing.
- C. The Contractor will employ the services of a Material Testing Agency in conformance with Section 014525 "Material Testing Agency" to perform acceptance testing on all earthwork and earthwork related work items. DEN Quality Assurance (QA) program will monitor all tests performed by the Contractor's Material Testing Agency and must be present on site during all acceptance testing and inspections.
- D. The City may employ the services of a Testing Agency (TA), which will perform all acceptance testing.

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**TECHNICAL SPECIFICATIONS  
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SECTION 014320 – DEN QUALITY ASSURANCE  
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- E. Laboratory and field-testing requirements to be conducted by the TA for materials and construction on this project are included in the appropriate Contract Documents. Where the Contract Documents reference the CDOT Standard Specifications for Road and Bridge Construction, the references shall also mean CDOT Field Materials Manual for schedule of tests unless otherwise stated. As a minimum, the TA described in this Section shall perform all applicable tests including the sampling and acceptance testing. In the event of such a conflict between the schedule and a specification in the Contract Documents, the more comprehensive testing shall govern unless otherwise noted.
- F. Inspections and tests conducted by the TA shall not in any way relieve the Contractor of the Contractor's responsibility and obligation to meet the requirements of all Contract Documents and referenced standards. Employment of the City's TA does not relieve the Contractor of providing the required Quality Control program.
- G. When inspections or tests by the TA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor.
- H. Samples will only be considered if taken at random.
- I. The Contractor is obligated to correct any item deemed deficient at no additional cost to the City.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014320**

**SECTION 014520****CONTRACTOR QUALITY CONTROL PROGRAM - FAA****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Contractor shall establish, provide and maintain an effective Quality Control Program that details the methods and procedures that will be taken to ensure that all materials and completed construction required by this Contract conform to Contract Documents and any other requirements, whether manufactured by the Contractor or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the Contract Documents, the Contractor shall assume full responsibility for accomplishing the stated purpose.

**1.03 LEVEL OF CONTROL**

- A. The intent of this Section is to explain the Contractor's need to establish a necessary level of control that will:
1. Adequately provide for the production of acceptable quality materials.
  2. Manager that the Contract requirements are being met.
  3. Allow the Contractor as much latitude as possible to develop the Contractor's own standards of control.

**1.04 REQUIREMENTS**

- A. The Contractor shall be prepared to discuss at the Preconstruction Conference, the Contractor's understanding of the quality control requirements. A written Quality Control Plan shall be submitted to the DEN Project Manager no later than ten (10) days after the Notice to Proceed. The Contractor shall not begin any construction, production or off-site fabrication of materials to be incorporated into the completed work until the Quality Control Plan has been reviewed and approved by the DEN Project Manager. No partial payment will be made for work or materials subject to specific quality control requirements until the Quality Control Plan has been reviewed and approved by the DEN Project Manager.
- B. The quality control requirements contained in this Section and elsewhere in the Contract Documents are in addition to and separate from the acceptance testing requirements. Certain acceptance testing requirements as noted in the specifications are also the responsibility of the Contractor.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 QUALITY CONTROL PROGRAM**

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**TECHNICAL SPECIFICATIONS**  
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- A. General Description: The Contractor shall establish a Quality Control Program to perform inspection and testing of all items of Work required by the Contract Documents, including those performed by subcontractors. This Quality Control Program shall ensure conformance to applicable specifications and plans with respect to materials, workmanship, construction, finish, and functional performance. The Quality Control Program shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the Contract Documents in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of quality control.
- B. Quality Control Plan: The following Quality Control Plan shall be submitted within ten (10) days of receiving the Administrative Notice to Proceed (NTP) in a MS Word or MS Excel format that can easily be incorporated into the FAA Construction Management Plan. The Contractor shall describe the Quality Control Program in a written plan. The Quality Control Plan shall provide a general description of minimum quality control monitoring required to be performed for each specification division until Final Acceptance by DEN.
1. The Quality Control Plan shall address and establish controls and documentation to ensure that only items or materials that have been accepted through successful inspection are used or installed. Identification and traceability of construction materials shall be provided throughout all inspections, test activities and records. For stored items, provisions shall be made for the control of the item/material identification, consistent with the expected duration and type of storage.
  2. The Quality Control Plan shall describe the methodology of monitoring, testing and exercising of all equipment, valves and/or assemblies to ensure the Work installed is in proper working order.
  3. In addition, the Quality Control Plan shall be organized to address, as a minimum, the following items:
    - a. Quality control organization and personnel.
    - b. Inspection requirements.
    - c. Quality control testing plan.
    - d. Documentation of quality control activities.
    - e. Requirements for corrective action when quality control and/or acceptance criteria are not met.
    - f. Testing Agencies Certifications, personnel certifications, equipment lists, test forms, report samples and forms, frequency of tests, specification references, and specification standards.
    - g. Acceptance tests required and methods of quality control for each activity included in the Contract Documents.
  4. The Contractor is encouraged to add any additional elements to the Quality Control Plan that he/she deems necessary to adequately control all production and/or construction processes required by this Contract.

### **3.02 QUALITY CONTROL ORGANIZATION**

- A. The Contractor's Quality Control Program shall be implemented by the establishment of a separate quality control organization. An organizational chart shall be developed to show all quality control personnel and how these personnel integrate with other management/production and construction functions and personnel.
1. The organizational chart shall identify all quality control staff by name and function and shall indicate the total staff required to implement all elements of the Quality Control Program, including inspection and testing for each item or work. If necessary, different technicians can be utilized for specific inspection and testing functions for different items of work. All personnel used for implementation of all or part of the

Quality Control Program shall be subject to the qualification requirements of this Section. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

- B. The quality control organization shall consist of the following minimum personnel:
1. Quality Control Manager:
    - a. The Quality Control Program shall be administrated by a Quality Control Manager. The Quality Control Manager shall be a full-time employee of the Contractor or a consultant engaged by the Contractor. The Quality Control Manager shall have a minimum of five (5) years of experience in airport and/or highway construction and shall have had prior quality control experience on a project of comparable size and scope as this Contract.
    - b. Additional qualifications for the Quality Control Manager shall include the following requirements:
      - 1) A licensed professional engineer with a minimum of five (5) years of airport or highway grading and drainage paving, field and laboratory testing, and quality control experience acceptable to the DEN Project Manager, or,
      - 2) A technician certified at Level III or IV by the National Institute for Certification in Engineering Technologies (NICET) for Construction Materials, Highway Materials, Highway Construction or five (5) years of highway and/or airport paving experience in all fields of work included in the scope of work and acceptable to the DEN Project Manager.
      - 3) Submit the following documentation to the DEN Project Manager for review:
        - a) A current resume including the individual's experience and qualifications.
        - b) Copy of current PE registration and/or all applicable certifications.
        - c) Four (4) references for work on projects completed within past five (5) years, including names, current organization, and telephone numbers.
    - c. The Quality Control Manager shall have full authority to institute any and all actions necessary for the successful implementation of the Quality Control Program to ensure compliance with the Contract Documents. The Quality Control Manager shall report directly to a responsible officer of the construction firm. The Quality Control Manager shall be on-site for a minimum of forty (40) hours per week during all production and shall be released from full-time duties only after written permission from the DEN Project Manager.
  2. Electrical Quality Control Manager: Depending on the project's scope of work, the Contractor shall provide a dedicated, full-time Electrical Quality Control Manager. The Electrical Quality Control Manager shall have no other responsibilities other than overall electrical quality control. The Electrical Quality Control Manager shall be a master electrician with a minimum of five (5) years electrical airfield construction experience at a commercial carrier airport. The Electrical Quality Control Manager shall be a Certified Senior Technician.
    - a. The Quality Control personnel:
      - 1) Shall be familiar with and prove proficiency in all aspects of inspections and testing he/she is supervising.
      - 2) Shall not perform any testing or inspection he/she is not certified to perform.
      - 3) Shall be subject to the approval of DEN Project Manager.
      - 4) Shall not report or be part of the production team on the Project.
  3. Quality Control Inspection Technicians: A sufficient number of Quality Control Inspection Technicians necessary to adequately implement the Quality Control Program shall be provided by the Contractor. The Quality Control Inspection Technicians shall have the authority to bring the Work into conformance with Contract requirements including stopping non-conforming work in progress. A document signed by an officer of the Contractor shall convey and acknowledge the Inspector's

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- authority. Inspection personnel shall be engineers, engineering technicians, or experienced craftsman with the following qualifications:
- a. Engineer-in-training with minimum two (2) years of airport/highway grading experience acceptable to the DEN Project Manager.
  - b. An individual with 3 years of highway and/or airport grading experience acceptable to the DEN Project Manager, with a Bachelor of Science degree in Civil Engineering, Civil Engineering. Technology or Construction.
  - c. The Quality Control personnel:
    - 1) Shall be familiar and prove proficiency in all aspects of inspections and testing he or she is supervising.
    - 2) Shall not perform any inspection he/she is not certified to perform.
    - 3) Shall be subject to the approval of DEN Project Manager.
    - 4) Shall not report or be part of the production team on the Project.
  - d. The Quality Control Inspection Technicians shall report directly to the Quality Control Manager and shall perform the following functions:
    - 1) Inspection of all materials, construction, plant and equipment for conformance to the Technical Specifications, and as required by Article 3.3 below
    - 2) Performance of all quality control tests as required by the Technical Specifications and Article 3.4 of this Section.
- C. If the DEN Project Manager determines that the Quality Control Manager or any of the Quality Control Manager's authorized support personnel are not effectively enforcing or performing the Quality Control requirements specified in the Contract, the DEN Project Manager will, in writing, require the Contractor to remove and replace such personnel from the Project at no cost to the City. No further work will be performed by the Contractor until an acceptable replacement for the replaced personnel is approved by the DEN Project Manager.
- D. Staffing Levels: The Contractor shall provide sufficient qualified quality control personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the Work, separate plant and field testing technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The Quality Control Plan shall state where different technicians will be required for different work elements. Should the DEN Project Manager determine that staffing levels are not sufficient to ensure compliance with the Quality Control Plan and Contract Documents, the Quality Control Manager shall take steps to bring staffing levels to an acceptable level.
- E. Suppliers and Subcontractors: The Quality Control Plan shall include a list of suppliers and subcontractors. The list shall include items to be supplied by each supplier and/or subcontractor and shall identify work to be performed by each subcontractor. The list shall be updated and submitted as required.
- F. Emergency Contact Information: Provide the name, company, title, work phone number, home phone number, and other means of contact for at least four (4) individuals. The individuals can be associated with production and/or quality control. The Emergency Contact list shall be revised in the event there is any change in any of the information and forwarded to the DEN Project Manager and DEN Maintenance Control (303-342-2800). The Emergency Contact list shall also include the project number, title and date of issue.

**3.03 INSPECTION REQUIREMENTS.**

- A. The Contractor shall utilize the following six-point inspection plan to ensure the conformance of the Work performed by the Contractor meets the requirements of the Contract Documents, the referenced codes and standards and the approved submittals:

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1. **Prework coordination:** Prior to the start of construction work on the Contract and prior to the start of work under each separate specification section and prior to the start of work where a change in a construction operation is contemplated by the Contractor and prior to a new subcontractor starting work, a coordination meeting will be held with the Contractor's Quality Control Manager, Project Manager, Superintendent, Foreman, Safety representative, Quality Control Inspector(s), MTA representative, and the DEN Project Manager, DEN Inspector(s), and DEN Quality Assurance Laboratory representative. Supervisory, Safety, and Quality Control representatives of all applicable subcontractors will also attend. The Contractor's Quality Control Manager will chair the meeting and shall distribute the proposed meeting agenda 48 hours prior to the meeting. Upon completion of the meeting, minutes including any revisions to the agenda shall be distributed within twenty-four (24) hours.
2. The purpose of the coordination meeting is to ensure that the Contractor's personnel have no misunderstandings regarding their safety and quality procedures as well as the technical requirements of the Contract. The following items shall be submitted to the DEN Project Manager no less than seventy-two (72) hours prior to the meeting and shall be presented and reviewed by the Contractor at the meeting held no less than forty-eight (48) hours prior to start of work:
  - a. Contract requirements and specifications.
  - b. Shop drawings, certifications, submittals and as-built drawings that apply.
  - c. Testing and inspection program and procedures.
  - d. Contractor's Quality Control Program.
  - e. Familiarity and proficiency of the Contractor's and subcontractor's workforce to perform the operation to required workmanship standards including certifications of installers.
  - f. Safety and environmental precautions to be observed.
  - g. Any other preparatory steps dependent upon the particular operation.
  - h. The Contractor's means and methods for performing the Work.
3. **Initial Inspection:** Upon completion of a representative sample of a given feature of the Work and no later than two (2) weeks after the start of a new or changed operation, the DEN Project Manager or the DEN Project Manager's designated representative will meet with the Contractor's Quality Control representative and applicable subcontractor's supervisor and their Quality Control representatives to check the following items, as a minimum:
  - a. Workmanship to established quality standards.
  - b. Conformance to Contract Documents and the accepted shop drawings.
  - c. Adequacy of materials and articles utilized.
  - d. Results of inspection and testing methods.
  - e. Adequacy of as-built drawings maintained daily.
  - f. Once accepted, the representative sample will become the physical baseline by which ongoing work is compared for quality and acceptability. To the maximum practical extent, approved representative samples of work elements shall remain visible until all work in the appropriate category is complete. Acceptance of a sample does not waive or alter any Contract requirements or show acceptance of any deviation from the Contract not approved in writing by the DEN Project Manager. The Contractor's Quality Control representative shall chair, prepare and distribute minutes of Quality Control meetings. Meeting minutes shall be distributed within twenty-four (24) hours of the meeting.
4. **Follow-up Inspection:** The Contractor's Quality Control representative will monitor the Work to review the continuing conformance of the Work to the workmanship standards established during the preparatory and initial inspections.
5. **Completion Inspection:** Forty-eight (48) hours prior to the completion of an item or

segment of work and prior to covering up any work, the Contractor will notify the DEN Project Manager who will verify that the segment of work is substantially complete, all inspections and tests have been completed and the results are acceptable. The purpose of this inspection is to allow further corrective work upon, or integral to, the completed segment of work. THIS IS NOT AN ACCEPTANCE INSPECTION. If any items are determined to be deficient, need correction or are non-conforming, a deficiency list will be prepared and issued to the respective Contractor for correction, repair or replacement of any deficient or non-conforming items. The DEN Project Manager and Contractor's Quality Control representative will verify the correction of the deficient and/or non-conforming items prior to the start of the next operation.

6. Pre-Final Acceptance Inspection: Prior to requesting a Pre-final Acceptance Inspection by DEN, all work and operational systems to be inspected shall be satisfactorily completed and tested by the Contractor. The Contractor's written request for this inspection shall be made seventy-two (72) hours in advance. With the request shall come a list of any known deficiencies (punch list) and the time frame in which they will be corrected. If the list is too large or contains too many significant items, in the opinion of the DEN Project Manager, no inspection will be held due to the incompleteness of the Work.
  - a. The DEN Project Manager will schedule the Pre-final Acceptance Inspection and will add to the punch list deficient items discovered during the inspection. If during the inspection the list becomes too large or too many significant items are on the list, the inspection will be canceled. After the inspection is completed, the deficiency list will be transmitted to the Contractor for correction of the deficient items.
7. Final Acceptance Inspection: After the Contractor has completed all items on the deficiency list (generated from the Pre-final Acceptance Inspection) he/she shall request a Final Acceptance Inspection. The request shall be made in writing at least seventy-two (72) hours in advance of the inspection. All areas must be cleaned and ready for turnover prior to this inspection. The DEN Project Manager, the design consultant, a representative of the funding agency, if applicable, and other interested parties will inspect the subject Work to ensure that all deficiencies have been satisfactorily attended to and that no new deficiencies have appeared and that all systems are completely functional. Any outstanding or additional deficient items will be noted and handled per the requirements of the Pre-final Acceptance Inspection noted above until the Work is acceptable to the DEN Project Manager.

### **3.04 QUALITY CONTROL TESTING PLAN.**

- A. As a part of the overall Quality Control Program, the Contractor shall implement a Quality Control Testing Plan as required by the specifications. The testing plan shall include the minimum tests and test frequencies required by each item in the Contract Documents as well as any additional quality control tests that the Contractor deems necessary to adequately control production and/or construction processes.
- B. The testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:
  1. Specification item number (e.g., P-401).
  2. Item description (e.g., Plan Mix Bituminous Pavements).
  3. Test type (e.g., gradation, grade, asphalt content).
  4. Test standard (e.g., ASTM or AASHTO test number, as applicable).
  5. Test frequency (e.g., as required by specifications or minimum frequency when requirements are not stated).

6. Responsibility (e.g., plant technician).
  7. Control requirements (e.g., target, permissible deviations).
- C. The testing plan shall contain a statistically based procedure of random sampling for acquiring test samples in accordance with ASTM D 3665. The DEN Project Manager shall be provided the opportunity to witness quality control sampling and testing.
- D. All quality control test results shall be documented by the Contractor as required by this Section.

### **3.05 DOCUMENTATION.**

- A. The Contractor shall maintain current quality control records of all inspections and tests performed. These records shall include factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, results of inspections or tests, nature of defects, deviations, causes for rejection, etc., proposed remedial action, and corrective actions taken.
- B. These records must cover both conforming and defective or deficient features and must include a statement that all supplies and materials incorporated in the Work are in full compliance with the terms of the Contract. Legible copies of these records shall be furnished to the DEN Project Manager daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the Contractor's Program Manager.
- C. Specific Contractor quality control records required for the Contract shall include, but are not necessarily limited to, the following records:
1. Certificates of compliance shall be submitted minimum thirty (30) days prior to the product's incorporation into the Work.
  2. Quality Control Charts for materials shall be established as required by the individual specification sections.
  3. Daily Foreman Report: The Foreman shall report daily construction activities using the Daily Foreman Report form QCP-1 as included in Specification Section 019990 "Standard Forms". The reports shall be completed in their entirety and shall as a minimum include the following:
    - a. Daily activities.
    - b. Quantities of material placed and completed.
    - c. Weather.
    - d. Safety issues.
    - e. Personnel.
    - f. Equipment on site with time used.
    - g. Equipment under repair.
    - h. Work delays.
    - i. Possible delays.
    - j. Materials delivered.
    - k. The reports shall be signed by the responsible foreman and Contractor Superintendent. The DEN Project Manager shall be provided a copy of each daily construction report on the work day following the day of record.
  4. Daily Quality Control Inspection Reports: Each Contractor Quality Control Inspection Technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations on forms QCP-2 and QCP-2-2 included in Section 019990 "Standard Forms". The reports shall be completed in their entirety, shall

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provide factual evidence that continuous quality control inspections have been performed and shall, as a minimum, include the following:

- a. Technical Specification item number and description.
  - b. Compliance with approved submittals.
  - c. Proper storage of materials and equipment.
  - d. Adherence to plans and specifications.
  - e. Review of quality control tests.
  - f. Compliance of quality control testing frequencies.
  - g. Identify inspections conducted, results of inspections, location and nature of defects found, causes for rejection, remedial or corrective actions taken or proposed.
  - h. The reports shall be signed by the responsible Quality Control Inspection Technician and the Program Manager. The DEN Project Manager shall be provided a copy of each report on the workday following the day of record.
5. Test Reports: The Contractor shall be responsible for establishing a system which will record all quality control test results. Daily test reports shall document the following information:
- a. Technical Specification item number and description.
  - b. Test designation.
  - c. Location.
  - d. Date of test.
  - e. Control requirements.
  - f. Test results.
  - g. Causes for rejection.
  - h. Recommended remedial actions.
  - i. Retests.
  - j. Fresh concrete properties tests and in-place moisture-density tests shall be reported in legible draft form to the DEN Inspector immediately at the test site. Any failing test shall be reported separately to a DEN Inspector or the DEN Project Manager within two (2) hours after the discovery.
  - k. Test results from each day's work period shall be transmitted to the DEN Project Manager on the next work day. These initial daily test reports shall be signed by the responsible Quality Control Technician and the Program Manager.
  - l. Typed final laboratory and field tests shall be provided to the DEN Project Manager as specified in paragraph 3.5.D "Weekly Summary Reports" below.

**D. Weekly Summary Reports:**

1. Typed final laboratory and field test reports summarizing the activities and results for the quality control tests and inspections for each week shall be prepared by the ITA and submitted to the DEN Project Manager. The weekly summary report shall meet the requirements of Section 014525 "Material Testing Agency" and be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all test types, test locations, testers, test results, worksheets showing all calculations used, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, the material supplier, installer, and Contractor. Retests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report. A current Correction Action Report (CAR) log shall also be included in the weekly summary report.

**3.06 CORRECTIVE ACTION REQUIREMENTS**

- A. The Quality Control Plan shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process under control. The requirements for corrective action shall include both general requirements for operation of the Quality Control Program as a whole, and for individual items of work contained in the specifications.
- B. The Quality Control Plan shall detail how the results of quality control inspections and tests will be used for determining the need for corrective action and shall contain clear sets of rules to gauge when a process is out of control and the type of correction to be taken to regain process control.
- C. When applicable or required by the specifications, the Contractor shall establish and utilize statistical quality control charts for individual quality control tests. The requirements for corrective action shall be linked to the control charts.

**3.07 SURVEILLANCE BY THE DEN PROJECT MANAGER**

- A. All items of material and equipment shall be subject to surveillance by the DEN Project Manager at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate quality control system in conformance with the requirements detailed herein and the applicable Contract Documents. In addition, all items of materials, equipment and work in place shall be subject to surveillance by the DEN Project Manager at the site for the same purpose.
- B. Surveillance by the DEN Project Manager does not relieve the Contractor of performing quality control inspections of either on-site or off-site Contractor's or subcontractor's work.

**3.08 NONCOMPLIANCE**

- A. The DEN Project Manager will notify the Contractor of any noncompliance with any of the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Any notice, when delivered by the DEN Project Manager or the DEN Project Manager's authorized representative to the Contractor or the Contractor's authorized representative at the site of the work, shall be considered sufficient notice.
- B. In cases where quality control activities do not comply with either the Contractor's Quality Control Program or the Contract provisions, or where the Contractor fails to properly operate and maintain an effective Quality Control Program, as determined by the DEN Project Manager, the DEN Project Manager may:
  - 1. Order the Contractor to replace ineffective or unqualified quality control personnel or subcontractors
  - 2. Order the Contractor to stop operations until appropriate corrective actions are taken.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

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- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014520**

**SECTION 014525****MATERIAL TESTING AGENCY****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Contractor shall employ the services of a Material Testing Agency; hereafter referred to as the Contractor Testing Agency (CTA). This Section identifies the requirements for the Contractor to employ a Material Testing Agency and identifies the required activities of the Material Testing Agency.
- B. Laboratory and field-testing requirements to be conducted by the CTA for materials and construction methods used on this project are included in the appropriate technical specifications. Where the Specifications reference the CDOT Standard Specifications for Road and Bridge Construction, the references shall also mean CDOT Field Materials Manual for schedule of tests unless otherwise stated. As a minimum, the CTA described in this Section shall perform all applicable tests listed in the manual including the independent assurance sampling and testing. In the event of such a conflict between the schedule and a specification in these technical provisions, the more comprehensive testing shall govern unless otherwise noted.
- C. Inspections and tests conducted by the CTA shall not in any way relieve the Contractor of the Contractor's responsibility and obligation to meet all specifications and referenced standards. Employment of the CTA does not relieve the Contractor of providing the required Quality Control program.
- D. When inspections or tests by the CTA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor as per this Section.
- E. Samples will only be considered if taken at random. The Contractor shall permit representatives of the City to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.
- F. The Contractor is obligated to correct any item deemed deficient at no additional cost to DEN.

**1.03 SUBMITTALS**

- A. All submittals shall comply with requirements of Sections 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal requirements.

**1.04 CONTRACTOR SUBMITTAL OF PROPOSED TESTING AGENCIES**

- A. The Contractor shall employ the services of a CTA that has been accredited by AASHTO or CCRL or an approved equal to perform the tests required in the Contract. The CTA may

also provide technicians to perform the required inspections. However, inspection and testing cannot be performed simultaneously by the same technician. The Contractor shall receive written acceptance from the DEN Project Manager of the CTA prior to any permanent work being installed or tested.

- B. The Contractor shall not submit for acceptance to the DEN Project Manager any testing agency or laboratory utilized in the design or construction document preparation or presently employed by DEN as part of DEN Quality Assurance, Material Testing, or special inspection agencies.
- C. For consideration of acceptance, the Contractor shall submit to the DEN Project Manager the following items received from the CTA:
  - 1. Affidavit of current accreditation from a national certification and/or accreditation program(s).
  - 2. Evidence that the CTA Laboratory is accredited to perform the testing required in the Contract Documents.
  - 3. Resumes and evidence of professional engineer registration and licensing in the State of Colorado for the personnel reviewing and signing test reports.
  - 4. Resumes and current certifications verifying that CTA management and supervisory personnel, laboratory staff, field testing technicians, and inspecting technicians are qualified in accordance with ASTM C 1077, D 3666, D 3740, and E 329 requirements to perform the Work. NICET, ACI, WAQTC, LabCAT, CDOT, NRMCA, PCA, AWS, ASNT certifications or a degree in a related engineering field with construction field experience that can demonstrate qualifications. A list summarizing all management, supervisory, laboratory, field testing, and inspection personnel assigned to the Project including the testing and/or inspection each individual will be performing, certifications held by each individual, and the expiration date of each certification.
  - 5. A matrix indicating each technical specification section, paragraph, quantity and type of sampling and/or testing required.
  - 6. Copies of all laboratory, field testing, and inspection report forms.

#### **1.05 SUBMITTAL OF REPORTS**

- A. Test results shall be submitted by the Contractor to the DEN Project Manager after completion of inspections/tests by the CTA and prior to incorporation of the items into the Work unless the test or inspection must be done during or after installation.
- B. All field test results including but not limited to fresh concrete properties and in-place moisture-density shall be reported in legible draft form to the DEN Inspector immediately at the test site. Any failing test shall be reported separately to the DEN Inspector or DEN Project Manager. The draft test results shall also be attached to the Daily Quality Control Inspection Report (reference Section 014510 "Contractor Quality Control") and transmitted to the DEN Project Manager the next workday.
- C. Typed test reports shall be provided to the DEN Project Manager as specified in the "Weekly Reports" Article in this Section. The test reports shall be numbered sequentially in chronological order. Individual tests shall be numbered sequentially. The reports and tests shall also be organized per specification section. All test results must be reviewed and signed by a registered licensed engineer in the State of Colorado. The signature represents that the test procedures used are in strict conformance with the applicable testing standard, the calculated data are true and accurate, the tools and equipment used were in calibration, the sample was not contaminated and the persons running the test were qualified.

- D. Reports of inspections and test activities are record documents and shall be maintained in a manner that provides integrity of item identification, acceptability, and traceability. Reports shall identify the following:
1. Contractor's name.
  2. DEN Contract number and title.
  3. Material Testing Agency name.
  4. Name of items inspected/tested including a physical description and, as applicable, model and make.
  5. Quantity of items.
  6. Inspection/test procedure used. If national standards are used, any deviation from these standards.
  7. Date the sample was taken and the date the test was made.
- E. Location (by coordinates, building grid or station number and elevation) of where tests and/or samplings were performed including environmental condition where applicable. Include plan drawing indicating location of test, lot size and location and work item sampled or tested.
1. Name of inspector/tester.
  2. In the event the testing or sampling is a re-test or re-sampling, reference the previous respective testing or sampling report.
  3. Specified requirements in the Contract that the item must meet. Include reference to technical specification section and paragraphs.
  4. Acceptability.
  5. Deviations/nonconformance.
  6. Evaluation of results.
  7. All information required for the specific test as specified in the applicable ASTM standard.
  8. Signature of authorized evaluator.

#### **1.06 WEEKLY SUMMARY REPORTS**

- A. The CTA and Quality Control Manager shall prepare and submit to the DEN Project Manager a weekly summary report each week, which summarizes by specification section all work activities and results for the quality control tests and inspections conducted during that period. The weekly summary report shall be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all inspections, test types, test locations, testers, test results, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, and the material supplier, installer and Contractor. Re-tests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report.
- B. The weekly report shall be submitted per Sections 013300 requirements.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

**3.01 REMOVAL OF NONCONFORMING MATERIAL**

- A. The Contractor is obligated to correct or remove nonconforming materials, whether in place or not. If necessary, the DEN Project Manager will send written notification to the Contractor to correct or remove the defective materials from the project. If the Contractor fails to respond, the DEN Project Manager may order correction, removal, and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred related to correcting, removing, and/or replacing the defective materials.

**3.02 PERFORMANCE**

- A. If the DEN Project Manager determines that the CTA or its personnel are not effectively enforcing or performing the testing and documentation requirements specified in the Contract, the DEN Project Manager will require, in writing, the Contractor to remove and replace the CTA or such personnel at no cost to DEN.

**3.03 CONTROL OF MEASURING AND TEST EQUIPMENT**

- A. The CTA shall select measuring and test equipment in such a manner as to provide proper type, range, accuracy, calibration, and tolerance for determining compliance with specified requirements. Measuring and test devices shall be calibrated, adjusted and maintained at prescribed intervals prior to use based upon equipment stability and other conditions affecting measurement. Provisions shall be made for the proper handling and storage of equipment. Calibration shall be accomplished using certified standards that have a known traceable relationship to the National Institute of Standards and Technology. Every calibrated measuring and test device shall show the current status, date of last calibration and the due date for the next calibration. Calibration records shall be maintained onsite as quality records and shall be made available for inspection upon the DEN Project Manager's request.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014525**

**SECTION 014545****SPECIAL INSPECTION AGENCY AND OWNER TESTING AGENCIES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Verify if adopted codes below are current at time of Project.
- C. Special Inspection Statement issued as part of the application for building permit for the specific task or project.

**1.02 SUMMARY**

- A. The City will employ the services of Special Inspection Agencies (SIA). This Section identifies the requirements for the Contractor to coordinate, facilitate, and support DEN and its agents and consultants to fulfill the requirements of Special Inspection.
  - 1. Any additional tests deemed necessary by the Building Official, Engineer of Record, Special Inspector or DEN Project Manager to assure these agencies that all material and work on the Project meet the requirements of the Contract and all applicable codes and regulations.
  - 2. Minimum Laboratory and field testing requirements to be conducted by the SIA for materials and construction on this Project are included in the Table at the end of this Section.
  - 3. All caissons and piers drilling on this Project shall be continuously inspected by the SIA hired by DEN directly or through the Engineer of Record or its sub-consultants.
  - 4. The Contractor shall not perform any work that could cover work or material that has not passed a special inspection or that requires the presence of the special inspector to meet the requirements of continuous or periodic inspection.
  - 5. It is the responsibility of the Contractor to plan and coordinate all testing requirements on the project to assure no delays are occurring due to the lack of inspection or testing.
  - 6. The Contractor must allow sufficient time in the schedule to perform all required inspection and testing.
  - 7. All rework due to nonconformance, failing tests or rework to test covered work prior to proper inspection and testing shall be borne by the Contractor.
  - 8. All re-inspections and re-testing costs due to non-conformances or failing tests or revisiting to test covered or incomplete work shall be borne by the Contractor at a cost of \$100 per hour in addition to all direct and indirect costs associated with testing.
  - 9. Periodic welding inspection shall include the minimum of fitting inspection and final inspection at all times.
  - 10. Inspections and tests conducted by the SIA shall not relieve in any way the Contractor of the Contractor's responsibility and obligation to meet all specifications and referenced standards. Employment of the SIA does not relieve the Contractor of providing the required Quality Control program.

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11. When inspections or tests by the SIA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor. Reference Article 5.1 of this Section.
12. Samples will only be considered if taken at random. The Contractor shall permit representatives of the City to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.
13. The Contractor is obligated to correct any item deemed deficient at no additional cost to DEN.

**1.03 SUBMITTALS**

- A. All submittals shall comply with requirements of Section 013300 "Submittals" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal requirements.

**1.04 CONTRACTOR SUBMITTAL OF PROPOSED CONTRACTOR'S TESTING AGENCIES**

- A. Projects requiring Special Inspection where the Contractor is utilizing a certified shop to produce material. DEN requires that testing be performed to satisfy the certification be no less than the following: All material and workmanship meets the requirements of a Contractor Material Testing Agency.
- B. The Contractor shall employ the services of a Testing Agency for process control and acceptance by the subcontractors and suppliers or material delivery for Contractor convenience or contractual obligations with others.
- C. The Contractor's Testing Agency must be accredited agency to perform any test required to be submitted for compliance with a Contract requirement or for use of data by DEN agencies for any official use, for examples and not to grant any obligation on the DEN Project Management Team, any payment reduction factor calculation. Any dispute or requirement to recalibrate testing equipment or machine, proof of compliance of material that was installed in contrary to manufacturer recommendation, any apparent defect due to adverse weather, improper installation, incomplete material record.
- D. Contractor's Testing Agency must be a qualified entity that has performed testing on similar jobs in size and complexity and has been accredited by AASHTO or CCRL or an approved equal to perform the tests required in the Contract. The CTA may also provide technicians to perform the required inspections. However, inspection and testing cannot be performed simultaneously by the same technician.
- E. The Contractor shall not submit for acceptance to the DEN Project Manager any testing agency or laboratory utilized in the design or construction document preparation or presently employed by DEN as part of DEN Quality Assurance.
- F. For consideration of acceptance, the Contractor shall submit to the DEN Project Manager the following items received from the CTA:
  1. Affidavit of current accreditation from a national certification and/or accreditation program.
  2. Evidence that the CTA is accredited to perform the testing required in the Contract Documents.
  3. Resumes and evidence of professional engineer registration and licensing in the State of Colorado for the personnel reviewing and signing test reports.

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4. Resumes and current certifications verifying that SIA management and supervisory personnel, laboratory staff, field testing technicians, and inspecting technicians are qualified in accordance with ASTM C 1077, D 3666, D 3740, and E 329 requirements to perform the Work. NICET, ACI, WAQTC, LabCAT, CDOT, NRMCA, PCA, AWS, ASNT certifications, or a degree in a related engineering field with construction field experience can demonstrate qualifications. A list summarizing all management, supervisory, laboratory, field testing, and inspection personnel assigned to the Project including the testing and/or inspection each individual will be performing, certifications held by each individual, and the expiration date of each certification.
5. A matrix indicating each technical specification section, paragraph, quantity and type of sampling and/or testing required.
6. Copies of all laboratory, field testing, and inspection report forms.

**1.05 SUBMITTAL OF REPORTS**

- A. Test results shall be submitted by the Special Inspector and/or DEN Testing Agency to the DEN Project Manager after completion of inspections/tests by the SIA/OTA and prior to incorporation of the items into the Work unless the test or inspection must be done during or after installation.
- B. All field test results including but not limited to fresh concrete properties and in-place moisture-density shall be reported in legible draft form to the DEN/PMT Inspection and the Contractor Quality Control Manager immediately at the test site. Any failing test shall be reported separately to the DEN/PMT Inspector or DEN Project Manager within two (2) hours after the discovery.
- C. The Contractor's Quality Control Manager or his/her Authorized representative must keep track and official record of all tests passed, failed, or defected. The Contractor shall be fully responsible to show passing tests of all required elements. The lack of any passing test record of any required element does not waive the requirement to of testing or inspection as required by the Contract Documents and the IBC. The Contractor shall bear all costs associated with recovering missing tests including but not limited to the cost of the cost of disassembling, testing or inspecting, reassembling, and any indirect time or cost impacts of a missing required test or inspection.
- D. Typed test reports shall be provided by the testing agency to the DEN Project Manager as specified in Part 1 of this Section Weekly Summary Reports. The test reports shall be numbered sequentially in chronological order. Individual tests shall be numbered sequentially. The reports and tests shall also be organized per specification section. All test results must be reviewed and signed by a registered licensed engineer in the State of Colorado. The signature represents that the test procedures used are in strict conformance with the applicable testing standard, the calculated data are true and accurate, the tools and equipment used were in calibration, the sample was not contaminated and the persons running the test were qualified.
- E. A plan of work and administrative procedure shall be established to assure that all test and inspections frequency required are performed and all defects are tracked and retested and re-inspected to meet all applicable specifications, codes, and standards.
- F. The Contractor shall track all tests performed on the daily reports and shall submit a statement for each phase of the Work showing all elements of Quality have been completed and all defects are addressed or scheduled to be addressed prior to covering the Work.
- G. Reports of inspections and test activities are record documents and shall be maintained in a manner that provides integrity of item identification, acceptability, and traceability. Reports shall identify the following:

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1. Contractor's name.
2. DEN Contract number and title.
3. Testing Agency name.
4. Name of items inspected/tested including a physical description and, as applicable, model and make.
5. Quantity of items.
6. Inspection/test procedure used. If national standards are used, any deviation from these standards.
7. Date the sample was taken and the date the test was made.
8. Location, by coordinates, building grid or station number, of where tests and/or samplings were performed including environmental condition where applicable. Include plan drawing indicating location of test and work item sampled or tested.
9. Name of inspector/tester.
10. In the event the testing or sampling is a re-test or re-sampling, reference the previous respective testing or sampling report.
11. Specified requirements in the Contract that the item must meet. Include reference to technical specification section and paragraphs.
12. Acceptability.
13. Deviations/nonconformance.
14. Corrective action.
15. Evaluation of results.
16. All information required for the specific test as specified in the applicable ASTM standard.
17. Signature of authorized evaluator.

**1.06 WEEKLY SUMMARY REPORTS**

- A. The SIA/OTA shall prepare and submit to the DEN Project Manager a weekly summary report each week that summarizes by specification section all work activities and results for the quality control tests and inspections conducted during that period.
- B. The weekly summary report shall be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all inspections, test types, test locations, testers, test results, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, and the material supplier, installer and Contractor.
- C. Re-tests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report. The SIA shall identify costs of re-testing or additional site visits required due to scheduling changes by the Contractor. A current Corrective Action Report log (CAR) shall also be included in the weekly summary report.
- D. The weekly report shall be submitted per Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" requirements.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION****3.01 CORRECTION OR REMOVAL OF NONCONFORMING MATERIAL**

- A. The Contractor is obligated to correct or remove nonconforming materials, whether in place or not. If necessary, the DEN Project Manager will send written notification to the Contractor to correct or remove the defective materials from the Project. If the Contractor fails to respond, the DEN Project Manager may order correction, removal, and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred related to the correction, removal and/or replacement of the defective materials.

**3.02 PERFORMANCE**

- A. If the DEN Project Manager determines that the SIA or its personnel are not effectively enforcing or performing the testing and documentation requirements specified in the Contract, the DEN Project Manager will, state in writing, the requirement for the Contractor to remove and replace SIA or such personnel at no cost to DEN.

**3.03 CONTROL OF MEASURING AND TEST EQUIPMENT**

- A. The SIA shall select measuring and test equipment in such a manner as to provide proper type, range, accuracy, calibration, and tolerance for determining compliance with specified requirements. Measuring and test devices shall be calibrated, adjusted and maintained at prescribed intervals prior to use based upon equipment stability and other conditions affecting measurement.
- B. Provisions shall be made for the proper handling and storage of equipment. Calibration shall be accomplished using certified standards that have a known traceable relationship to the National Institute of Standards and Technology. Every calibrated measuring and test device shall show the current status, date of last calibration and the due date for the next calibration. Calibration records shall be maintained onsite as quality records and shall be made available for inspection upon the DEN Project Manager's request.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 014545**

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**SECTION 015050****MOBILIZATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Section 012910 "Schedule of Values"

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparatory work and operations including, but not limited to the following:
  - 1. Those necessary for the movement of personnel, equipment, supplies, and incidentals to the work site.
  - 2. For the establishment of all offices, buildings and other facilities necessary for the Work on the Project.
  - 3. For all other work and operations that must be performed or costs incurred prior to beginning work on the various Contract items on the work site.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Submit a Mobilization Schedule a minimum of fourteen (14) days prior to first billing for mobilization.

**1.04 DELIVERY**

- A. Delivery to the work site of construction tools, equipment, materials, and supplies shall be accomplished in conformance with all local governing regulations.

**PART 2 - PRODUCTS****2.01 PRODUCTS**

- A. Provide construction tools, equipment, materials, and supplies of the type and quantities that will facilitate the timely execution of the Work.

**PART 3 - EXECUTION****3.01 EXECUTION AND REMOVAL**

- A. Provide personnel, products, construction materials, equipment, tools, and supplies at the work site at the time they are required and scheduled to be installed or utilized.

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 015050 – MOBILIZATION**

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**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. Refer to Section 013210 – Schedule, for details regarding mobilization scheduling, billing, and payment.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. Refer to Article 1104 – Changes in the Work, Contract Price or Contract Time of the General Contract Conditions (current edition).
- B. Payment shall be made under C-105.

**END OF SECTION 015050**

**SECTION 015210  
TEMPORARY FACILITIES**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

**1.03 DESCRIPTION**

- A. The Work specified in this Section consists of furnishing, installing, operating, maintaining, and removing temporary construction barriers, enclosures, and field facilities including the Contractor's construction offices, staging areas, yards, storage areas, electrical power, telephone, water, fire protection, and sanitary service.
- B. Construction Offices, Construction Yards and Storage Areas:
1. The Contractor's offices, construction yards and laydown and storage areas shall be located as shown on the Contract Drawings and/or as designated by the DEN Project Manager. All construction offices, staging areas, and material storage areas are to occur within these areas. The DEN Project Manager may but is not required to approve the Contractor to use office, laydown areas and storage areas at DEN but not designated specifically for this Project.
  2. Any activity that is expected to result in disturbance of the ground surface equal to or greater than one acre or part of a larger project that is expected to disturb equal to or greater than one acre, is required to be identified in their Erosion Control permit. These areas include, but are not limited to, laydowns, borrow areas, stockpiles, and storage areas regardless of the location.
  3. All areas of ground disturbance are required to be stabilized in accordance with State, local, and airport rules and regulations prior to permit termination and/or closure of the Contract.
  4. The Contractor shall restore any area on DEN property that becomes contaminated as a result of its operations in accordance with Airport Rule and Regulation 180. Restoration shall be either to applicable standards under Federal and State law or to such other levels as may be required by the Manager of Aviation, at the Manager's sole discretion.
  5. All temporary facility sites must be inspected prior to Contract closeout.
    - a. The DEN Project Manager or authorized representative shall conduct an inspection of contractor areas used during the life of the project. These areas include but are not limited to, staging areas, laydown areas, borrow areas, and contractor yards and offices.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 015210 – TEMPORARY FACILITIES****DENVER INTERNATIONAL AIRPORT**  
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6. The DEN Project Manager will ensure these areas have been properly stabilized in accordance with DEN Rules and Regulations and required permits. Site must be restored to the condition in which the City initially provided to the Contractor. A representative from DEN Environmental Services shall be present during the final walk through.
  7. Contractor materials shall be managed in accordance with all applicable Environmental Regulations.
  8. Temporary facilities which the Contractor desires to locate in secondary laydown and staging areas adjacent to the Work or within the project limits are subject to approval by the DEN Project Manager. If approved, these areas must also be included as part of the erosion control permit.
  9. Access to and security of the Contractor's construction offices, yard, temporary facilities, and storage areas shall be as shown on the Contract Drawings or as specified in the Contract Special Conditions.
  10. Contractor Field Office:
    - a. The Contractor shall acquire all necessary permits for installation and construction work related to the Contractor's field office and fencing.
    - b. The Contractor shall provide, as part of the Contractor's on-site field office, a conference room for weekly meetings. Minimum size to accommodate fifteen (15) people with the currently approved schedule posted on a wall. The conference room shall have a network connection with a computer monitor, and a telephone with speakerphone functionality.
    - c. Jack the mobile office unit off its wheels and provide support. Enclose the underside of the trailer with weatherproof skirting.
    - d. Install tie downs in compliance with all applicable codes.
    - e. Provide access to the field office and easily accessible space for parking six (6) full size passenger automobiles as a minimum. Grade the field office site, access roadway, and parking area for drainage, and surface with gravel paving or crushed stone.
    - f. Water and sewer lines to the field office, if installed, shall be installed so they will not freeze.
  11. All Contractor Storage Yards must be fenced. Submit fencing plan and typical details to DEN Project Manager at least seven (7) days before planned execution for review and acceptance.
  12. In accordance with Denver Fire Department Requirements, all Temporary Facilities shall have signage that lists the following information:
    - a. Company Name
    - b. Contact Telephone Number
    - c. Facility Address
- C. Electrical Service
1. Provide lighting and power for field offices, storage facilities and other construction facilities and areas.
  2. Provide power centers for electrically operated and controlled construction facilities including tools, equipment, testing equipment, interior construction lighting, heating, cooling and ventilation equipment.
  3. Provide night security lighting at secured areas within construction limits at offices, storage facilities, temporary facilities and excavated areas.
  4. Provide battery operated or equivalent emergency lighting facilities at construction areas where normal light failures would cause employees to be subjected to

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 015210 – TEMPORARY FACILITIES**

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hazardous conditions. Test such facilities monthly and maintain a record of these tests for the DEN Project Manager's review.

5. Contractor shall bear all costs of temporary electric service permits, fees, and deposits required by the governing authorities, and connection charges and temporary easements including installation, maintenance, and removal of equipment.

D. Telephone/Communications Service:

1. The contractor shall furnish, install, and maintain broadband telecommunications service in the contractor's main field office. Contractor shall also furnish, install, and maintain telephony service at the main field office, or cellphone(s) such that the DEN Project Manager is able to reach a contractor's representative at all times.
2. Comply with requirements of Division 26 Sections.

E. Water Service:

1. The Contractor shall make all connections and extensions required and shall make use of water in direct support of the Work. The Contractor shall install an approved Water Department tap at the City's water source prior to obtaining any water. The Contractor shall arrange and pay for its supply/distribution system from the City's point of connection. The location and alignment of the Contractor's temporary supply/distribution system must be approved by the DEN Project Manager prior to its installation. The Contractor shall leave in place all above ground and underground water distribution facilities unless otherwise directed by the DEN Project Manager.
2. The Contractor shall not use in place fire hydrants or standpipes as sources for construction water or potable water.
3. Comply with requirements of Division 22 Sections.

F. Fire Protection:

1. Furnish, install, and maintain temporary portable fire protection equipment throughout the construction period at all buildings (including the project site), maintenance shops, and fuel storage on all large construction equipment and at the location of any flammable materials or construction materials.
2. Comply with requirements of Division 21 Sections.

G. Sanitary Service:

1. Furnish, install, and maintain temporary sanitary facilities and services throughout the construction period.
2. Ensure that separate or single user toilets shall be provided to ensure privacy between the sexes.
3. Provide general washing facilities adequate for the number of employees.
4. Provide special washing facilities adequate for the number of employees engaged in the application of paints, coating, and other volatile or hazardous materials.

#### **1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Submit a shop drawing within five (5) days of the Notice to Proceed that shows the following:
  1. Temporary facilities equipment and materials (include manufacturer's literature).

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**TECHNICAL SPECIFICATIONS**  
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**SECTION 015210 – TEMPORARY FACILITIES****DENVER INTERNATIONAL AIRPORT**  
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2. Details and layout of temporary installations including fences, roads, parking, buildings, storage areas, signage, and drainage plans.
3. Lighting plan showing temporary lighting facilities, electrical service panel location, electrical circuit diagram, and anticipated light level on the working roadway, pathway, or construction surface.
4. As-built description of any temporary underground utilities referenced to the Airport grid and benchmark system within five (5) days of completion of the installation.
5. Copies of all permits for all temporary facilities.

**1.05 QUALITY CONTROL**

- A. Provide products for, and the execution of, the Work of this Section that will satisfy the requirements of all applicable codes. Provide products that satisfy the requirements of the applicable codes.

**PART 2 - PRODUCTS****2.01 ELECTRICAL SERVICE**

- A. Provide temporary power and lighting equipment consisting of fixtures, transformers, panel boards, groundings, lamps, switches, poles, conduits and wiring sized and capable of continuous service and having adequate capacity to ensure a complete operating system. Comply with NEMA and Division 26 requirements.

**2.02 TELEPHONE/COMMUNICATIONS SERVICE**

- A. Provide equipment that is compatible with that of the current DEN service provider and the telephone exchange to which the Contractor connects.

**2.03 POTABLE WATER SERVICE**

- A. Provide sanitary materials and equipment that satisfies the requirements of codes and regulations pertaining to temporary water systems. Bottled products may be used if those products comply with codes. Clearly label portable containers having a dispensing tap and used only for drinking water. Provide single service disposable cups and a sanitary container for dispensing cups. A trash receptacle shall be provided and maintained beside each portable water supply.
- B. If paints, coatings and other volatile or hazardous materials injurious to humans will be applied as part of the Contract, provide washing facilities with warm water of approximately 120 degrees F.

**2.04 FIRE PROTECTION**

- A. Fire extinguishers shall be UL rated and shall comply with the International Fire Code with City of Denver amendments.

**2.05 SANITARY SERVICE**

- A. Provide materials and equipment adequate for the intended purposes, which will neither create unsanitary conditions nor violate the codes applicable to temporary sanitary facilities. Enclosures for toilet and washing facilities shall be weatherproof, sight proof, ventilated and sturdy, and shall be maintained in clean conditions.

- B. Provide portable type toilet facilities that satisfy the requirements of OSHA.
- C. Provide washing facilities as needed. Furnish soap, single-service paper towels, towel dispenser, and towel receptacle.

### **PART 3 - EXECUTION**

#### **3.01 ELECTRICAL SERVICE**

- A. The approximate location of primary power lines is shown on the Construction Drawings. The Contractor shall locate electrical service where it will not interfere with equipment, storage spaces, traffic, and prosecution of the Work or the work of others. Installation shall present a neat and orderly appearance and shall be structurally sound. Maintain service in a manner that will ensure continuous electrical service and safe working conditions.
- B. Comply with requirements of Division 26 Sections.

#### **3.02 TELEPHONE/COMMUNICATION SERVICE**

- A. Install temporary telephone service in a neat and orderly manner, and make structurally and electrically sound to ensure continuous service. Modify, relocate, and extend, as work progress requires. Place conduit and cable where those products will not interfere with traffic, work areas, materials, handling equipment, storage areas, and the work of other contractors. Service lines may be aerial.

#### **3.03 WATER SERVICE**

- A. Install the systems in a neat and orderly manner. Make them structurally and mechanically sound. Provide continuous service. Modify, relocate, and extend the systems as the Work progresses.
- B. Comply with requirements of Division 22 Sections.
- C. Locate systems where they will be convenient to work stations, sanitary facilities, and first aid station but will not interfere with traffic, work areas, materials handling equipment, storage areas, or the work of other contractors.
- D. Provide sanitary bubbler drinking fountains if potable water service is available. Disinfect water piping before using for the potable water service.
- E. Install vacuum breakers, backflow preventers, and similar devices in a manner and location that will prevent temporary water from returning to the water mains.
- F. Do not incorporate any part of temporary water distribution system into the permanent water distribution system.

#### **3.04 FIRE PROTECTION**

- A. Install products in conformance with the requirements of the applicable Denver Fire Department and OSHA regulations.
  - 1. Provide functional, approved fire extinguishers that are clearly identified for fire and an accessible supply of water during the period of construction. These fire extinguishers shall remain in place until permanent fire protection systems are functional.
- B. Instruct construction personnel as to location and use of temporary fire protection

equipment.

- C. Comply with requirements of Division 21 Sections.

### **3.05 SANITARY SERVICE**

- A. Place temporary sanitary and washing facilities in a neat and orderly manner within the limits of the Work and convenient to the workstations. Make these facilities structurally and mechanically sound. Modify, relocate, and extend the facilities as required by progress of the Work.
- B. Service toilets at those time intervals that will minimize the accumulation of wastes and prevent creation of unsanitary conditions, but not less than once a week.
- C. The waste from the sanitary and wash facilities shall be disposed of in accordance with all applicable rules, regulations, and laws and with the least environmental impact.

### **3.06 FENCING**

- A. Contact all utility service companies prior to planning fence location and post locations for certification of current utilities. Locate pothole posts planned within five (5) feet of known utilities.

### **3.07 SIGNAGE**

- A. Contractor shall not provide any signage for temporary facilities without prior approval from the DEN Project Manager.

### **3.08 REMOVAL**

- A. The Contractor shall locate all temporary facilities including the underground utilities so they can be completely removed without damaging permanent work or the work site of other contractors.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 015210**

**SECTION 015215**

**FIELD OFFICES**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of furnishing, installing and maintaining a field office at the work site for the City's use.
- B. DEN Shall provide field offices at the location specified by the Contract Documents.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 015215**

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 015215 – FIELD OFFICES**

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**SECTION 15525**  
**TRAFFIC CONTROL**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of furnishing plans and designs for traffic control and haul routes, implementing these plans with all necessary personnel and equipment. Installation may require but not be limited to signage, cones, flaggers, signal lights, lighting and temporary roads.
- B. All Work must be in conformance with the "Manual of Uniform Traffic Control Devices for Streets and Highways" (MUTCD) and CDOT Standard Plans regarding traffic control.
- C. The Contractor must coordinate the Contractor's proposed traffic control needs with the needs of other contractors on the airport construction site in writing through the DEN Project Manager.
- D. Refer to Article 805 – Protection of Street and Road System in the General Contract Conditions, Current Edition.

**1.03 QUALITY CONTROL**

- A. Temporary signal work shall conform to CDOT Standard Plans and the current version of the CDOT Standard Specifications.
- B. Designate a qualified person to inspect and test traffic control devices daily and to ascertain that those devices are continuously operating, serviceable, in place, and clean.
- C. Provide certified personnel who will be responsible for design, implementation, and inspection of traffic control needs.

**1.04 SUBMITTALS**

- A. Refer to Technical Specifications Sections 013300 "Submittals" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Submit a Traffic Control Plan (TCP) that includes, at a minimum, the following list of items for approval before starting Work. Submit an updated TCP when necessary to modify traffic operation or undertake a construction activity that creates a different traffic pattern:
1. Traffic blockade and reductions anticipated to be caused by construction operations.
  2. Temporary detours.
  3. A Method of Handling Traffic (MHT) must be submitted and approved by the DEN Project Manager, which at a minimum will show and describe proposed location, dates, hours, and duration of detours, vehicular traffic routing, and management, traffic control devices for implementing detours and details of barricades.

- C. Submit Haul Route Plan for both on- and off-site hauls. The Haul Route Plan shall be submitted 30 days prior to hauling any permanent material. The Plan shall be updated as the Contractor's plans change.
- D. Specific Traffic Considerations: The DEN Project Manager may require the Contractor to revise the Traffic Control Plan to address traffic considerations not included in the Contractor's plan.
- E. Shutdown requests for any impact to traffic must be submitted for approval a minimum of five days before the intended shutdown. These requests will be made through the DEN Project Manager.

## **PART 2 - PRODUCTS**

### **2.01 TRAFFIC CONTROL DEVICES**

- A. Devices including signs, delineators, striping, barriers, barricades, and high-level warning devices shall conform to the latest revision of the MUTCD and the latest revision of the Colorado Department of Transportation Standard Plans.

## **PART 3 - EXECUTION**

### **3.01 TEMPORARY TRAFFIC CONTROL DEVICES**

- A. Place temporary control devices in a manner that allows for the smooth flow of traffic at the posted speed limit, limiting hazards or abrupt changes in direction.
- B. Place traffic cones or delineators as directed by the MUTCD. Operate warning lights between sunset and sunrise.
- C. Place control devices so that approaching traffic is alerted to hazards and variances to normal traffic patterns.
- D. Clean and repair damaged devices or replace them with new devices as required.

### **3.02 TEMPORARY TRAFFIC STRIPING AND PAVEMENT MARKINGS**

- A. Full-compliance striping is required at all times per the MUTCD.
- B. Temporary signs must be replaced with permanent signing within three days per the MUTCD.

### **3.03 FLAGGERS**

- A. Furnish flaggers where required for safety and by the MHT.

### **3.04 CONSTRUCTION VEHICULAR TRAFFIC**

- A. Restrict construction vehicles to approved haul routes.
- B. Haul routes on the airfield must be approved by Security.

### **3.05 CONTROLLING VEHICULAR AND PEDESTRIAN FLOW ADJACENT TO WORK SITE**

- A. Ensure that construction operations will not impede normal traffic. Where work is in the area

of pedestrian or occupant activity, the Contractor shall detail a plan for managing pedestrian traffic safely. Refer to Title 8 - Protection of Persons and Property, Section 801.1 in the General Contract Conditions, Current Edition.

### **3.06 SIGNS**

- A. Refer to Title 8, Article 802 - Protective Devices and Safety Precautions in the General Contract Conditions, Current Edition.
  - 1. The Contractor must contact the DEN Project Manager a minimum of five (5) working days in advance of construction for installation, relocation, or removal of regulatory parking signs.
- B. Coordinate and pay any expense associated with the furnishing and installation of all parking regulatory signs, such as "No Stopping Any Time," etc., at the work site.
- C. Furnish and install any necessary advance detour or guidance signing.
- D. Authorize, modify, and install regulatory parking controls and vehicle turn restrictions.
- E. Implement those traffic control modifications outside of the traffic control zone that are necessary to manage diverted traffic.
- F. Clean and repair damaged signage or replace with new signage within 24 hours, and provide mitigation as required to maintain site safety until signage has been installed.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. Measurement for Traffic Control shall be per lump sum. This item shall include installation, maintenance, re-positioning (as required by phase or the DEN Project Manager) and removal upon completion; of the low profile barricades (with lights), tubular barricades, temporary haul routes and temporary signage, temporary pavement markings, gates, and any other item associated with providing traffic control for the project including, but not necessarily limited to, the preparation and submittal of traffic control plans.
- B. Measurement for Flagger shall be made per hour. This shall include all associated costs with providing the flaggers. The quantity to be measured for flagging will be the total number of actual flagging hours that are used in place and actively flagging. Payment will not be made for time spent by flaggers to set up and take down construction traffic control devices or for 'break flaggers' not actively flagging and shall instead be incidental to Traffic Control work item.
- C. Measurement for Gate Guard shall be made per hour. This shall include all associated costs with providing the Gate Guards.
- D. Measurement for Gate Guard Shack shall include the installation, maintenance, and removal of the guard shack at Gate(s) shown on the Contract Drawings including all required incidental items described in the Contract Drawings.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT.**

- A. Item 015525-1 Traffic Control Payment will be made at the contract unit price per lump sum. This price shall include installation, maintenance, re-positioning (as required by phase or the DEN Project Manager) and removal upon completion; of the low profile barricades (with lights), tubular barricades, temporary haul routes and temporary signage, temporary pavement markings, gates, and any other item associated with providing traffic control for the project.
- B. Item 015525-2 Flagger Payment per hour.
- C. Item 015525-3 Gate Guard Payment per hour.
- D. Item 015525-4 Gate Guard Shack Payment will be made at the contract unit price per lump sum. This price shall include the installation, maintenance, and removal of the guard shack at Gate G7 including all required incidental items described in the Contract Drawings.

**END OF SECTION 015525**

**SECTION 015719****TEMPORARY ENVIRONMENTAL CONTROLS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Specifications Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Title 8 - Protection of Persons and Property in the General Contract Conditions, 2011 Edition, specifically the following articles:
  - 1. Article 806 - Protection of Drainage Ways
  - 2. Article 807 - Protection of Environment
  - 3. Article 808 - Hazardous and Explosive Materials or Substances
  - 4. Article 809 - Archaeological and Historical Discoveries
- C. Denver Municipal Airport System Rules and Regulations, Part 180-Environmental Management.
- D. DEN Environmental Management System (EMS)

**1.02 SUMMARY**

- A. The Work specified in this Section consists of identifying, and avoiding or mitigating adverse environmental impacts to air, water, soil, and other natural resources caused by construction activities.
  - 1. The Contractor, in conducting any activity on airport property or in conducting work for an airport project not on airport property, shall comply with all applicable airport, local, state, and federal rules, regulations, statutes, laws, and orders.
  - 2. Work shall not commence on any project until all FAA approvals have been received, applicable permits have been issued and signed by permittee, and all inspection requirements have been satisfied in accordance with State and local permitting requirements.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Within ten (10) days after Notice to Proceed on a task order, the Contractor shall submit the following if applicable, unless waived by the DEN Project Manager:
  - 1. Submittals pertaining to water quality management:
    - a. Construction Activities Stormwater Discharge Permit
      - 1) City and County of Denver
        - a) Sewer Use & Drainage Permit (SUDP)
        - b) Construction Activities Stormwater Discharge Permit (CASDP)
      - 2) Colorado Department of Public Health and Environment (CDPHE) Colorado Discharge Permit System (CDPS) Authorization to Discharge (Contractor need not submit a copy of the general permit or the general permit rationale)

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 015719 – TEMPORARY ENVIRONMENTAL**  
**CONTROLS**

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- a) CDPS General Permit for Stormwater Discharges Associated with Construction Activities
  - b) CDPS General Permit for Associated with Non-Extractive Industrial Activity
  - c) CDPS General Permit for Construction Dewatering Discharges (Prior to obtaining a CDPS General Permit for Construction Dewatering Discharges permit, the Contractor shall submit a draft permit application and the final permit application for DEN review and approval PRIOR to submittal to CDPHE. The Contractor need not submit a copy of the general permit or the general permit rationale.
- 3) Upon request the contractor shall provide the following documentation
- a) Stormwater Management Plan (SWMP)
  - b) CASDP Inactivation Request
  - c) CDPS Notice of Termination
  - d) Permit Transfer Application
  - e) Modification Application
  - f) Discharge Monitoring Reports (DMRs)
  - g) A copy of the well permit from the state Division of Water Resources for every new well that diverts or for the monitoring of groundwater. (A draft copy of the Notice of Intent for any borehole structure filed with the state Division of Water Resources).
  - h) Section 404 related permitting (Prior to obtaining a permit issued by the US Army Corps of Engineers, the contractor shall submit a draft copy of the application and coordinate with efforts DEN Environmental Services).
- 4) Revisions or amendments to the CASMP by the Contractor: At the completion of the Project, after final stabilization has been achieved and accepted in accordance with CASDP requirements, the Contractor shall submit a copy of the CASDP Inactivation Request.
2. Submittals pertaining to sewage holding tanks associated with buildings and trailers: For purposes of this Section, the generic term “sewage holding tank” means “onsite wastewater treatment system (OWTS),” “individual sewage disposal system (ISDS),” “privy vault,” “septic tank,” or “septic system”:
- a. Draft copy of the permit application for a sewage holding tank.
  - b. Copy of the Sewer Use & Drainage Permit issued by the Denver Department of Public Works.
  - c. Copy of the OWTS permit issued by the Denver Department of Environmental Health.
3. Submittals pertaining to air quality management:
- a. Copy of any permit issued by the CDPHE Air Pollution Control Division (APCD)
4. Submittals pertaining to storage tanks and containers:
- a. Copy of the approved application issued by the State of Colorado, Department of Labor and Employment, Division of Oil and Public Safety, for installation of petroleum, or other regulated substances, storage tanks located on airport property and used for the Project.
  - b. Copy of permits issued by the Denver Fire Department for storage tank installations, storage tank removals, and hazardous materials use/storage.
  - c. Copy of Spill Prevention, Control, and Countermeasure (SPCC) Plan for petroleum storage tanks and containers with capacity of 55 gallons of oil or greater located on airport property and used for the Project.
5. Copies of any other plans, permits, permit applications, correspondence with regulatory agencies, including violations, waste manifests, results of laboratory analyses, or other environmental documentation required for the Project not

previously identified herein.

#### **1.04 RELATED DOCUMENTS**

- A. Code of Federal Regulations (CFR) Publications, including, but not limited to, the following:
  - 1. 33 CFR 323 - Permits for discharges of dredged or fill materials into waters of the United States.
  - 2. 40 CFR - Protection of Environment.
  - 3. 49 CFR 171-180 Hazardous Materials Transportation Regulations.
- B. Colorado Revised Statutes, including, but not limited to, the following:
  - 1. Water Quality Control, Title 25, Article 8.
  - 2. Air Quality Control, Title 25, Article 7.
  - 3. Hazardous Waste, Title 25, Article 15.
  - 4. Noise Abatement, Title 25, Article 12.
  - 5. Petroleum Storage Tanks, Title 8, Article 20.5.
  - 6. Liquefied Petroleum Gas (LPG) Storage Tanks, Title 8, Article 20, Part 4.
  - 7. Solid waste regulations.
- C. City and County of Denver Executive Orders, including, but not limited to, the following:
  - 1. Executive Order No. 115 - Required Use of Denver-Arapahoe Disposal Site (Landfill).
  - 2. Executive Order No. 123 - Office of Sustainability and Citywide Sustainability Policy.
  - 3. Denver Revised Municipal Code, Title II, Sections 48-44 and 48-93 - Solid Waste.
  - 4. Denver Revised Municipal Code, Title II, Section 4-43 – Idling Restriction.
- D. City and County of Denver Construction Activities Stormwater Manual.
- E. Any other applicable rules, regulations, ordinances, and guidance must be followed as applicable.
- F. Refer to Section 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- G. Refer to Section 017419 "Construction Waste Management" for waste management requirements

### **PART 2 - PRODUCTS**

#### **2.01 PRODUCTS**

- A. Products required for the Work shall meet all Environmental Requirements.
- B. At a minimum, products for erosion and sediment control must conform to the technical requirements contained in the City and County of Denver "Construction Activities Stormwater Manual" and the current version of the "Mile High Flood District's Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices".

### **PART 3 - EXECUTION**

**3.01 AIR POLLUTION CONTROLS**

- A. The Contractor shall use appropriate control measures to comply with applicable air quality permit requirements. Additionally, the Contractor must be aware of the following procedures and techniques while conducting construction activities on DEN property. NOTE: Application of dust control measures should be discussed and outlined in the Dust Control Plan.
1. Apply water as needed to the construction site haul roads, disturbed surface areas and public access roads as needed to suppress dust. The use of chemical stabilizer can be requested by the Contractor. The type of stabilizer to be used and locations of use must be included in the Dust Control Plan, which must be approved by the DEN Project Manager prior to application.
  2. The Contractor shall suspend all earthmoving activities if wind speed exceeds 30 mph. For purposes of this Section, the generic term "earthmoving" means clearing, grubbing, excavation, topsoil removal, backfilling, embankment work, grading, trenching, drilling, and installation of borings. Contractors are expected to check wind speeds with the airport's ramp tower to demonstrate compliance with this requirement. In addition, the Project may be shut down if two of three of the Runway Visual Range (RVR) instruments read visibility of 2,400 feet or less. The instruments are used by FAA Control Tower personnel to ensure safe aircraft operations. Costs for shutdowns due to wind velocities or RVR readings shall not be grounds for delay or extra cost claims.
- B. Burning of materials is strictly prohibited on DEN property.

**3.02 WATER POLLUTION CONTROLS**

- A. The Contractor shall conduct construction activities in accordance with all applicable permit requirements. In addition, the Contractor shall comply with the following procedures and requirements while conducting activities on DEN property:
1. Water encountered during construction cannot be discharged to the stormwater system or placed onto the ground surface without a permit AND prior written approval by the DEN Project Manager. If groundwater or stormwater is anticipated to be encountered and the Contractor desires to discharge it to the stormwater system or onto the ground surface, then the Contractor must obtain an appropriate CDPS discharge permit in advance of the discharge unless this activity is specifically authorized under the CDPS Construction Stormwater Permit.
  2. If water is encountered and the Contractor desires to discharge these waters to the sanitary sewer system, then the Contractor must obtain approval from DEN Environmental Services in advance of the discharge.
  3. The Contractor shall ensure that stormwater that comes in contact with storage areas does not become impacted and discharged to the stormwater sewer system or to an impervious surface. Furthermore, any materials in storage areas shall not be stored directly on the ground.
  4. The Contractor shall not operate any valves, sluice gates or other drainage appurtenances related to any DEN sewer system without the prior approval of both the DEN Project Manager and DEN Environmental Services. Any violation of this directive may result in the payment of a financial penalty by the Contractor if the State of Colorado assesses such a penalty.

**3.03 EROSION CONTROL AND SEDIMENTATION CONTROL**

- A. This Work consists of constructing, installing, maintaining and removing, if required, temporary and permanent control measures during the life of the Contract (and possibly

afterward) until the Contractor achieves final stabilization of the site to prevent or minimize erosion, sedimentation, and pollution of any state waters in accordance with all Environmental Requirements.

- B. The Contractor is responsible for compliance with all requirements in accordance with the CASDP, the City and County of Denver Construction Activities Stormwater Manual, the approved CASMP, and CDPS-issued permits.
- C. Temporary facilities, including but not limited to storage areas, laydowns, borrow areas, and contractor offices and work yards, shall be managed in accordance with Section 015210 "Temporary Facilities".
- D. Clean soil fill may be stockpiled in any area that has been previously approved and signed off by the DEN Section Manager of Construction, Design and Planning, and Environmental Services. Soil stockpiles are considered a potential pollutant source and must be addressed in the CASMP and/or SWMP.
- E. Make immediately available, upon the DEN Project Managers request, all labor, material, and equipment judged appropriate by the DEN Project Manager to maintain suitable erosion and sediment control features. These actions requested by the DEN Project Manager take precedence over all other aspects of project construction that have need of the same labor, material and equipment, except those aspects required to prevent loss of life or severe property damage.

### **3.04 CONSTRUCTION OF CONTROL MEASURES FOR EROSION AND SEDIMENTATION**

- A. The Contractor must install control measures in accordance with the most recent version of the "Mile High Flood District's Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices and the City and County of Denver Construction Activities Stormwater Manual".
  - 1. Deviations from these two documents are allowed with written consent from the City and County of Denver CASDP Inspector.

### **3.05 STORAGE OF OIL, FUELS, OR HAZARDOUS SUBSTANCES**

- A. The Contractor shall prevent oil or other hazardous substances, as defined in federal and state regulations, from entering the ground, drainage or local bodies of water, and shall provide containment, diversionary structures, or equipment to prevent discharged oil from reaching a watercourse and take immediate action to contain and clean up any spill of oily substances, petroleum products, or hazardous substances. The Contractor shall provide one or more of the following preventive systems at each petroleum storage site:
  - 1. Dikes, berms, or retaining walls capable of containing at least 100% of the volume of the largest single tank and equipped with sufficient freeboard to contain precipitation events. The secondary containment must be "sufficiently impermeable" to prevent a release to the environment.
  - 2. Culverting, curbing, guttering, or other similar structures capable of containing at least 100% of the volume of the largest single tank and freeboarding from precipitation.
- B. The provision of such preventive systems shall be subject to acceptance by the DEN Project Manager prior to tank installation and shall follow the SPCC regulations (40 CFR Part 112).
- C. Prior to bringing any containers of 55-gallon or above capacity onto DEN property for storage of oil, fuel, or other petroleum substances, the Contractor may be required to prepare an SPCC Plan that conforms to 40 CFR Part 112. The plan must include a

certification either from a Professional Engineer or self-certification, if applicable, as well as management approval from the legally responsible Contractor representative.

### **3.06 SPILL RESPONSE AND NOTIFICATION**

- A. The Contractor is responsible for all spills that may result from its activities. For ANY suspected or confirmed release or spill of oil, fuel, solid waste, hazardous waste, unknown materials, lavatory waste, or miscellaneous chemicals, etc., that occurs as the result of the Contractor's activities on DEN property, the Contractor is required to take immediate action to mitigate the release or spill and report it to the DEN Project Manager and to the DEN Communications Center at (303) 342-4200.
- B. The Contractor is responsible for notifying the appropriate regulatory agency in the event suspected and/or confirmed releases are identified, in accordance with regulatory requirements.

### **3.07 SITE REMEDIATION AND RESTORATION**

- A. The Contractor shall be required to perform any necessary site assessment and remediation activities required by applicable regulatory agency.
- B. During routine construction activities, the Contractor is required to manage soils using typical construction techniques. The Contractor must differentiate between soils and wastes, including contaminated soils versus clean soils, and determine those materials that can remain on DEN property and those that must be transported off site for disposal.
- C. During all construction activities that require the management of soils, the Contractor must notify the DEN Project Manager and DEN Environmental Services (ES) that soils being managed may be impacted by industrial activities conducted at the airport. "Process knowledge" pertaining to previous use and/or impact for the locations under construction can be used to determine whether impacted soils are probable. Also, common indices such as soil staining and odor can be used as a determination for the probable condition. If probable contamination conditions are suspected, the Contractor will notify the DEN Project Manager and DEN ES immediately. At that time, which may be before the Work is initiated where indicative conditions exist, all work will cease until a sampling and analysis approach is determined and implemented by the proper responder.
- D. If the site conditions warrant based on evidence of spillage or contamination, process knowledge, and/or visual or olfactory observations, the Contractor may be required to conduct sampling and analysis to confirm that no remedial action is required. Prior to conducting any removal activities, the Contractor must provide a Scope of Work to the DEN Project Manager describing the proposed site assessment activities.
- E. The impacted project will modify its operation to include a segregation area where probable impacted soils can be placed, stored, and sampled for characterization. Should the soil materials be determined to exceed the applicable standards, the DEN Project Manager, in conjunction with DEN ES, will be responsible for the proper disposal of these materials. Materials that are determined to contain contamination levels below the applicable standards can be considered clean soils and placed back into the excavation or reused elsewhere on DEN property. In accordance with Part 3 of this Section, materials removed that are suitable for recycling will be placed within areas designated on DEN to store these materials.
- F. The Contractor shall restore any area on the Airport that becomes contaminated as a result of its operations. Restoration shall be either to applicable standards under federal and state law or to such other levels as may be required by the Manager of Aviation, at the Manager's

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SECTION 015719 – TEMPORARY ENVIRONMENTAL  
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sole discretion. Such restoration shall be completed at the earliest possible time, and the Contractor's restoration shall be subject to inspection and approval by the Manager of Aviation or duly authorized representative. See DEN Rules & Regulations - Part 180.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. Temporary erosion and pollution control work (including dust control) required will be performed as scheduled or directed by the RPR, including erosion control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites. Temporary erosion and pollution control work will be paid as a lump sum. The Contractor shall submit unit prices, anticipated quantities, and costs of necessary permits for temporary erosion and pollution control items to the DEN PM.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. Temporary erosion and pollution control work will be paid for under:

Item 015719-1 Erosion Control Measures (Temporary) - per lump sum

**END OF SECTION 015719**

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**SECTION 015810**  
**TEMPORARY SIGNS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes requirements for the following:
1. Construction signage visible to the public.
  2. Temporary directional, informational, or regulatory signage.
- B. Related Requirements:
1. Section 015210 "Temporary Facilities" for requirements for temporary facilities.

**1.03 SUBMITTALS**

- A. Submit temporary sign finishes, materials and paint, etc., for review and approval by DEN Project Manager prior to any fabrication.

**1.04 QUALITY CONTROL**

- A. Construction and other temporary signage visible to the public must be commercial grade quality, professionally fabricated, and installed based on the location of the sign. The Contractor is responsible to maintain this signage until it is no longer needed, and to remove signage from the site.

**PART 2 - PRODUCTS****2.01 GENERAL**

- A. Interior signs that are visible and not physically accessible to the public may be made of rigid board, such as "Gator Board", with vinyl messages. All edges must be finished and all fasteners concealed.
- B. Interior signs that are visible and physically accessible by the public must be vandal-proof. Acceptable examples of vandal-proof signs are messages applied second surface with concealed tamperproof fasteners.
- C. Exterior signs must be vandal-proof and fabricated of weatherproof materials.

**PART 3 - EXECUTION****3.01 HARDWARE**

- A. Interior Signs: Attach with suitable adhesive and/or tape which may be removed without damage to finishes.

- B. Exterior Signs: Must be secured to withstand site conditions and varying weather conditions.

**3.02 SIGN FINISHES, MATERIALS, AND PAINT**

- A. Provide temporary signage to reflect permanent sign design and/or as directed by the DEN Signage Design Project Manager. Submit temporary sign finishes, materials and paint, etc., for review and approval prior to any fabrication.

**3.03 MAINTENANCE**

- A. The Contractor shall maintain temporary signage until it is no longer needed, as determined by DEN Project Manager.

**3.04 REMOVAL**

- A. The Contractor shall remove all temporary signs, and clean and refurbish affected areas to their original, or intended, condition.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 015810**

**SECTION 016000**  
**PRODUCT REQUIREMENTS**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
1. Section 012300 "Alternates" for products selected under an alternate.
  2. Section 012510 "Substitutions" for requests for substitutions.
  3. Section 014225 "Reference Standards" for applicable industry standards for products specified.

**1.03 DEFINITIONS**

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

**1.04 SUBMITTALS**

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number, title, and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. DEN Project Manager's Action: If necessary, DEN Project Manager will request additional information or documentation for evaluation within one week of receipt of a comparable product request. DEN Project Manager will notify Contractor[ through Construction Manager] of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.
  - a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
  - b. Use product specified if DEN Project Manager does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

### **1.05 QUALITY ASSURANCE**

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
  1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  2. If a dispute arises between contractors over concurrently selectable but incompatible products, DEN Project Manager will determine which products shall be used.

### **1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
  1. Store products to allow for inspection and measurement of quantity or counting of units.
  2. Store materials in a manner that will not endanger the Project, including the structure.
  3. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

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**TECHNICAL SPECIFICATIONS**  
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**SECTION 016000 – PRODUCT REQUIREMENTS**

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5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

**1.07 PRODUCT WARRANTIES**

- A. Refer to Title 18 - Warranties, Guarantees and Corrective Work of the General Contract Conditions, 2011 Edition.
- B. Submittal Time: Comply with requirements in Section 017720 "Contract Closeout."

**PART 2 - PRODUCTS****2.01 PRODUCT SELECTION PROCEDURES**

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged, and unless otherwise indicated, are new at time of installation.
  1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," DEN Project Manager will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
  1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  3. Products:
    - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
    - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in

"Comparable Products" Article for consideration of an unnamed product.

4. **Manufacturers:**
    - a. **Restricted List:** Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience [will] [will not] be considered[ unless otherwise indicated].
    - b. **Nonrestricted List:** Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
  5. **Basis-of-Design Product:** Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. **Visual Matching Specification:** Where Specifications require "match DEN Project Manager's sample", provide a product that complies with requirements and matches DEN Project Manager's sample. DEN Project Manager's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012510 "Substitutions" for proposal of product.
- D. **Visual Selection Specification:** Where Specifications include the phrase "as selected by DEN Project Manager from manufacturer's full range" or similar phrase, select a product that complies with requirements. DEN Project Manager will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## **2.02 COMPARABLE PRODUCTS**

- A. **Conditions for Consideration:** DEN Project Manager will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, DEN Project Manager may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## **2.03 MATERIALS**

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- A. General: Comply with requirements specified in other Sections.
  
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to DEN Project Manager for the visual and functional performance of in-place materials.

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 016000**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 016610****STORAGE AND PROTECTION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of providing storage and protection of the materials, products and supplies which are to be incorporated into the construction and indicating such storage areas on the working drawings with the location and dates when such areas will be available for each purpose.
- B. Related Requirements:
- C. Section 015210 "Temporary Facilities" for requirements for temporary facilities.

**1.03 SUBMITTALS**

- A. Refer to Technical Specifications Sections 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures. Submit concurrently with submittals required in Section 013223 "Construction Layout, As-built and Quantity Surveys".
- B. Submit working drawings showing locations of storage areas not indicated on the Contract Drawings.
- C. Submit descriptions of proposed methods and locations for storing and protecting products.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Materials required for the storage and protection of the items specified shall be durable, weatherproof and either factory finished or painted to present an appearance acceptable to the DEN Project Manager and the City. Storage facilities shall be uniform in appearance with similar materials used to the maximum extent possible.

**PART 3 - EXECUTION****3.01 GENERAL REQUIREMENTS OF EXECUTION**

- A. Palletize materials, products, and supplies that are to be incorporated into the construction immediately so they are stored off the ground. Material and equipment shall be stored only in those areas that are indicated as storage areas on the Contract Drawings and on the reviewed and accepted working drawings.
  - 1. Store these items in a manner which will prevent damage and facilitate inspection.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 016610 – STORAGE AND PROTECTION**

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2. Leave seals, tags, and labels intact and legible.
  3. Maintain access to products to allow inspection.
  4. Protect products that would be affected by adverse environmental conditions.
- B. Periodically inspect stored products to ensure that products are being stored as stipulated and that they are free from damage and deterioration.
1. Any damaged or deteriorated materials must be replaced immediately to avoid delays in the project schedule.
- C. Do not remove items from storage until they are to be incorporated into the Work.
- D. The Contractor shall ensure that all protective wrappings and coverings are secure and ballasted to prevent any items from deterioration and/or subsequent dislodgment. All items on the work site that are subject to becoming windborne shall be ballasted or anchored.

**3.02 HANDLING AND TRANSPORTATION**

- A. Handling:
1. Avoid bending, scraping, or overstressing products. Protect projecting parts by blocking with wood, by providing bracing or by other approved methods.
  2. Protect products from soiling and moisture by wrapping or by other approved means.
  3. Package small parts in containers such as boxes, crates, or barrels to avoid dispersal and loss. Firmly secure an itemized list and description of contents to each container.
- B. Transportation:
1. Conduct the loading, transporting, unloading, and storage of products so that they are kept clean and free from damage.

**3.03 STORAGE**

- A. Store items in a manner that shall prevent damage to DEN's property. Do not store hydraulic fluids, gasoline, liquid petroleum, gases, explosives, diesel fuel, and other flammables in excavations. Petroleum products and chemicals must be stored in closed containers within secondary containment.
- B. Provide sheltered weather-tight or heated weather-tight storage as required for products subject to weather damage.
- C. Provide blocking, platforms or skids for products subject to damage by contact with the ground.
- D. All material shall be stored according to the manufacturer's recommendations. Any material that has to be stored within specified temperature or humidity ranges shall have a 24-hour continuously written recording made of the applicable condition. Should the recording show that the material was not stored within the recommended ranges the material shall be considered defective and in nonconformance. If a certification from the manufacturer's engineering design representative is provided stating that the actual variations are acceptable and will in no way harm the material or affect warranties, then the deficiency will be considered corrected.
- E. Store hazardous material separately, with all material marked with a label showing the hazard and how to treat exposure to the material. Store incompatible materials separately.

- F. Extra materials that are left over at the completion of the Work shall be removed from the Project site by the Contractor unless they are required to be delivered to DEN as per Contract Document requirements for maintenance stock.

**3.04 LABELS**

- A. Flammable and combustible substances shall be stored in flammable storage cabinets that conform to OSHA requirements and shall be labeled "FLAMMABLE - KEEP FIRE AWAY" and "NO SMOKING".

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 016610**

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**TECHNICAL SPECIFICATIONS  
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**SECTION 017330**  
**CUTTING AND PATCHING**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Refer to Article 316, Cutting and Patching the Work in the General Contract Conditions, 2011 Edition

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Phased construction.
  - 4. Work by DEN.
  - 5. Work under separate contracts.
  - 6. Future work.
  - 7. Purchase contracts.
  - 8. DEN-furnished products.
  - 9. Contractor-furnished, DEN-installed products.
  - 10. Access to site.
  - 11. Coordination with occupants.
  - 12. Work restrictions.
  - 13. Specification and drawing conventions.
  - 14. Miscellaneous provisions.
- B. Related Requirements:
  - 1. Section 015210 "Temporary Facilities" for limitations and procedures governing temporary use of DEN's facilities.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

**1.03 DEFINITIONS**

- A. Cutting: Removal of existing construction to permit installation of or to perform other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

**1.04 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. Cutting and Patching Proposal: Submit a proposal describing procedures at least thirty (30) calendar days before the time cutting and patching will be performed, requesting approval to proceed. Obtain approval of the cutting and patching proposal by DEN Project Manager before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work or repair of other work damaged by unsatisfactory work. The proposal shall include at least the following information:
1. Identification of the Contract and the Contractor's name.
  2. Description of proposed work:
    - a. Scope of cutting, patching, alteration, or excavation.
    - b. The necessity for cutting or alteration.
    - c. Drawing showing location of the requested cutting or alteration, along with radar or x-ray report.
    - d. Trades that will execute the work.
    - e. Products proposed to be used.
    - f. Extent of refinishing to be done.
    - g. Alternatives to cutting and patching.
  3. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
  4. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted and proposed dates of interruption of service. Additionally, verify and locate anything in or behind the area prior to cutting.
  5. Proposed Dust Control and Noise Control Measures: Submit a statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
  6. Effect on the work and other surrounding work or on structural or weatherproof integrity of Project.
  7. Written concurrence of each contractor or entity whose work will be affected.
  8. Cost proposal, when applicable.

## **1.05 QUALITY CONTROL**

- A. Operational Elements: Do not cut and patch ANY operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance, decreased operational life or safety unless approved by the DEN Project Manager. Operations elements may include, but are not limited to the following:
1. Primary operational systems and equipment.
  2. Air or smoke barriers.
  3. Fire protection systems.
  4. Control systems.
  5. Communication systems.
  6. Conveying systems.

7. Electrical wiring systems.
  8. Operating systems of special construction as described in Divisions 13 and 26.
  9. HVAC systems.
- B. Miscellaneous Elements: Do not cut and patch ANY of the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or those results in increased maintenance, decreased operational life or safety unless approved by the DEN Project Manager. Miscellaneous elements may include, but are not limited to the following:
1. Water, moisture, or vapor barriers.
  2. Membranes and flashings.
  3. Exterior curtain wall construction.
  4. Equipment supports.
  5. Piping, ductwork, vessels and equipment.
  6. Noise control and vibration control elements and systems.
  7. Stud walls.
  8. Roofing system
- C. Visual Elements: Do not cut and patch ANY construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would reduce, in DEN's sole opinion, the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactorily manner.
1. If possible, retain the original installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage the original installer or fabricator, engage another recognized, experienced, and specialized firm as approved by the DEN Project Manager. Visual elements may include, but are not limited to:
    - a. Stonework and stone masonry.
    - b. Ornamental metal.
    - c. Matched-veneer woodwork.
    - d. Preformed metal panels.
    - e. Firestopping.
    - f. Window wall systems.
    - g. Terrazzo.
    - h. Flooring.
    - i. Wall coverings and finishes.
    - j. HVAC enclosures, cabinets, or covers.
- D. Cutting and Patching Conference: Before proceeding, meet at the Project site with all parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

## **1.06 WARRANTY**

- A. Existing Warranties: Remove, replace, patch and repair materials and surfaces cut or damaged during cutting and patching operations by methods and with materials so as not to void existing warranties.

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**DIVISION 01 – GENERAL REQUIREMENTS**  
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1. All effort shall be made to engage the original installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage the original installer or fabricator, engage another recognized, experienced and specialized firm as approved by the DEN Project Manager:
  - a. Processed concrete finishes.
  - b. Stonework and stone masonry.
  - c. Ornamental metal.
  - d. Matched-veneer woodwork.
  - e. Preformed metal panels.
  - f. Firestopping.
  - g. Window wall systems.
  - h. Terrazzo.
  - i. Flooring.
  - j. Wall coverings and finishes.
  - k. HVAC enclosures, cabinets, or covers.

**1.07 MATERIALS**

- A. General: All patching material shall be of the type specified for the material being patched. Comply with requirements specified in other specifications Sections.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually and texturally match existing adjacent surfaces to the fullest extent possible.
  1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials as approved by the DEN Project Manager.:

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers. Provide additional substrates or materials if required to achieve desired final results of patching work.
  2. Immediately notify the DEN Project Manager, in writing, of unsuitable, unsafe, or unsatisfactory conditions.
  3. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.
  4. Proceed with patching only after construction operations requiring cutting are complete and inspected by the DEN Project Manager.

**3.02 PREPARATION**

- A. Temporary Support: Provide temporary support of Work to be cut to ensure structural value

or integrity.

- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid or minimize interruption of services to occupied areas. Do not interrupt services in without approval from the appropriate authority. Refer to the appropriate Shutdown specification/procedures for applicable services.

### **3.03 POLLUTION CONTROLS**

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt.
  - 1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions such as ice, flooding, and pollution.
  - 2. For outdoor concrete saw cutting operations, slurry waste must be vacuumed up immediately to prevent migration off-site to pervious surfaces, surface waters or drains.
- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 1. Concrete slurry waste must be disposed of properly in accordance with applicable airport, local and state rules and regulations.
- C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to the condition existing before selective demolition operations began.

### **3.04 PERFORMANCE**

- A. General: Employ skilled workers to perform cutting and patching. Execute cutting and demolition by methods that will prevent damage to other work and will provide a proper surface to receive patching.
  - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
  - 2. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerance, and finishes.
  - 3. Restore work that has been cut or removed; install new products to provide complete work in accordance with requirements of the Contract Documents.
  - 4. Fit work airtight and fire safe to pipes, sleeves, ducts, conduit, and other penetrations through surfaces as required by the Contract Documents.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and other similar operations, including excavation, using methods least likely to damage elements retained to adjoining construction. If possible, review proposed procedures with original installer and comply with original installer's written recommendations.

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**TECHNICAL SPECIFICATIONS**  
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1. In general, use ground fault hand or small power tools designed (to short if metal is hit) for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete: Use a cutting machine such as an abrasive saw or a diamond-core drill.
  4. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other specification Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. For continuous surfaces, refinish entire unit to the nearest break line. For an assembly, refinish entire unit.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs on a painted surface, apply primer and intermediate paint coats over the patch and apply the final coat over the entire unbroken surface containing the patch. Provide additional coats until the patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
- D. Fire Rated Construction: Where rated elements are cut, reconstruct to approved designs to provide original fire rating.

**3.05 CORE DRILLING**

- A. The Contractor shall execute sufficient x-rays or ground penetrating radar (GPR) at each location planned for core drilling prior to submittal to the DEN Project Manager and to utility representatives for approval for core drilling. The request for approval shall be submitted a minimum seven (7) days before Core Drilling. The request for approval shall indicate on the x-ray or radar information regarding alternate locations or core drilling to avoid structural members and any embedded conduit. Embedded conduit may be metallic or plastic. The x-ray or radar system shall be capable of detecting both types of conduit.
- B. Core drilled “cores” and the core-drilled opening shall be inspected by DEN Project Manager Representatives prior to installation of any systems in new openings.
- C. The request for approval shall indicate on the x-ray or radar information regarding alternate locations or core drilling to avoid structural members and any embedded conduit. Embedded conduit may be metallic or plastic. The x-ray or radar system shall be capable of detecting both types of conduit.
- D. X-ray activities may not be performed during hours of activity or occupancy in the area of

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the x-ray system. The Contractor shall provide all manpower and barriers required to secure the areas affected by x-ray activities.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017330**

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**SECTION 017419****CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. This section describes the requirements for the disposal, recovery, reuse or recycling of non-hazardous and non-asbestos containing construction and demolition waste for both LEED or Envision and non-LEED or Envision projects. Note that LEED and Envision projects may have more specific requirements than identified in this section.
- B. Waste materials shall be managed in accordance with all local, state, and federal regulations.
- C. Related Requirements:
1. Section 013300 "Submittal Procedures" for submittal procedures.
  2. Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.

**1.03 DEFINITIONS**

- A. Solid Waste: means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, air pollution control facility, or other discarded material; including solid, liquid, semisolid, or contained gaseous material resulting from industrial operations, commercial operations or community activities. Solid waste does not include any solid or dissolved materials in domestic sewage, or agricultural wastes, or solid or dissolved materials in irrigation return flows, or industrial discharges which are point sources subject to permits under the provisions of the "Colorado Water Quality Control Act", Title 25, Article 8, CRS or materials handled at facilities licensed pursuant to the provisions on "Radiation Control Act" in Title 25, Article 11, CRS. Solid waste does not include:
1. Materials handled at facilities licensed pursuant to the provisions on radiation control in Article 11 of Title 25, C.R.S.
  2. Excluded scrap metal that is being recycled.
  3. Shredded circuit boards that are being recycled.
- B. Salvaged Materials: Defined as materials that exist on the site that can be reused, either on site or by another entity
- C. Recyclable Materials: Defined as materials that exist on site or are generated during the construction process that can be recycled and/or remanufactured into another material. Recyclable waste includes, but is not limited to, the following:
1. Concrete.
  2. Asphalt
  3. Ferrous and non-ferrous metals.

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**TECHNICAL SPECIFICATIONS**  
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4. Untreated wood, engineered wood.
  5. Gypsum wallboard.
  6. Corrugated cardboard, paper goods.
  7. Plastic.
  8. Glass, insulation.
  9. Carpet.
  10. Paints, fabric.
  11. Rubber.
  12. Stone and brick.
- D. Hazardous Waste: Per 6 CCR 1007-3, those substances and materials defined or classified as such by the Hazardous Waste Commission pursuant to 25-15-302, C.R.S., as amended. Also, see hazardous waste definition per 40 CFR 261.3.
- E. Asbestos Containing Materials: Per 5 CCR 1001-10: Regulation No. 8, The Control of Hazardous Air Pollutants, Part B The Control of Asbestos- material containing more than 1% asbestos

**1.04 SUBMITTALS**

- A. The Contractor shall submit a list of materials and products used with Safety Data Sheets (SDS). Examples include chemicals, solvents, fuels, building materials, etc.
1. A hardcopy or electronic link to the SDS for all materials and products used, if applicable.
  2. Identify storage methods for materials, including measures to segregate incompatible materials.
- B. The Contractor shall submit a Waste Management Plan to the DEN Project Manager and DEN Environmental Services. Minimum Waste Management Plan requirements include the following:
1. A list of all waste streams generated by the project
    - a. For each waste stream listed, the Contractor shall identify the handling/transportation method, the disposal method, and the disposal facility utilized.
    - b. If the Contractor anticipates generation of hazardous waste, the Contractor shall provide its USEPA (generator) identification number.
  2. Pollution Prevention Measures
    - a. Describe best practices that will reduce waste. For example, waste reduction measures, requiring vendors to deliver materials in reusable packaging, etc.
  3. Waste Management Plan Training.
  4. Storage of materials.
  5. Spill response.
- C. Approval of Contractor's Waste Management Plan does not relieve the contractor of responsibility for compliance with applicable environmental regulations.
1. The contractor shall maintain a record of the amounts of construction and demolition waste generated, recycled, reused, salvaged, or disposed of, in pounds for review.

2. Hauling manifest records shall be maintained and available for review. Manifest forms are available from the DEN Project Manager.

## **PART 2 - PRODUCTS**

### **2.01 DOCUMENTS**

- A. A list of all materials and products used. Examples include chemicals, solvents, solvents, fuels, curing compounds, etc.
  1. A hardcopy or electronic link to SDSs for all materials and products used.
  2. Identify storage methods, including measures to segregate incompatible materials.
  3. Refer to the Waste Management Plan

## **PART 3 - EXECUTION**

### **3.01 REQUIREMENTS**

- A. The Contractor shall not wash down equipment in such a manner as to flush grease, oils, detergents, and other contaminants onto the project site or onto airport property unless the waste is properly contained, treated, and disposed of.
- B. DEN maintains two dry concrete and asphalt recycling yards used for the accumulation and crushing of asphalt and concrete. The South Yard is located on 71st Ave just east of Jackson Gap Street. The North Yard is located on the south side of 110th, west of Queensburg Street.
- C. Concrete washwater cannot be discharged to surface waters or to storm sewer systems. Colorado Discharge Permit System (CDPS) coverage conditionally authorizes discharges to the ground of concrete wash water from washing of tools and concrete mixer chutes when appropriate best management practices (BMPs) are implemented.
  1. A bermed containment area that allows discharge water to infiltrate or evaporate;
    - a. Alternatives to bermed containment areas include portable concrete washout bins, and industrial washout containment systems where the accumulated waste is removed from the site and disposed of properly.
  2. Use of the washout site should be temporary (less than one year);
  3. The washout site should not be located in an area where shallow groundwater may be present, such as near natural drainages, springs, or wetlands
  4. Upon termination of the washout site, accumulated solid waste, which includes concrete waste and contaminated soils, must be removed from the site and disposed of properly.
- D. Rejected loads and/or other wet concrete or asphalt materials are **PROHIBITED TO BE PLACED ANYWHERE** on DEN property. These materials must be returned to the facility of origination or other permitted facility for proper disposal.
- E. Concrete saw cutting slurry must be properly contained and disposed of.
- F. Unknown or questionable materials encountered during construction activities, must immediately be reported to the DEN Communications Center at (303) 342-4200 and the DEN Project Manager.

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**TECHNICAL SPECIFICATIONS  
DIVISION 01 – GENERAL REQUIREMENTS  
SECTION 017419 – CONSTRUCTION WASTE  
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**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017419**

**SECTION 017420****CLEANING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this section consists of maintaining a clean, orderly, hazard free work site during construction, and final cleaning for the City's Final Acceptance. Failure to maintain the work site will be grounds for withholding monthly payments until corrected to the satisfaction of the DEN Project Manager.
- B. Refer to Article 325, Cleanup During Construction in the General Contract Conditions, 2011 Edition

**1.03 SUBMITTALS**

- A. Washing Plan: The Contractor shall prepare a plan describing the specific procedures and materials to be utilized for any equipment, vehicle, etc., washing activities. The plan must be submitted to the DEN Project Manager and approved by the DEN Project Manager and Environmental Services.
  - 1. Outdoor washing at DEN is not allowed unless the materials will be collected or managed in a manner to ensure that they will not enter the municipally owned separate storm sewer system (MS4). The materials can only be disposed at a location pre-approved by DEN Environmental Services (refer to DEN SWMP). Failure to comply with this requirement would result in the discharge of non-stormwater.
    - a. Outdoor wash materials that contain soaps or other cleaning chemicals must be collected and disposed of off site
  - 2. Indoor washing must be conducted in accordance with the Best Management Practices (BMPs) detailed in the DEN SWMP. Refer to Section 015719 "Environmental Controls". In addition, all indoor washing must be conducted in a manner that ensures that there are no prohibited discharges to the sanitary sewer system.
    - a. All wash-water that will be disposed of into the sanitary sewer must comply with City and County Denver rules and regulations pertaining to prohibited discharges.

**PART 2 - PRODUCTS****2.01 CLEANING MATERIALS**

- A. Utilize the type of cleaning materials recommended by the manufacturer for the surfaces to be cleaned.
- B. Maintain current Safety Data Sheets (SDS) on site for all chemicals. DEN Environmental Services must approve the chemicals used prior to discharge to the sanitary sewer system.

- C. Ensure proper disposal of all wastes generated from the use of these materials. The Contractor must ensure compliance with all environmental regulations. No wastes can be disposed of on DEN property.

## **PART 3 - EXECUTION**

### **3.01 INTERIM CLEANING**

- A. Clean only when dust and other contaminants will not precipitate upon newly painted surfaces.
- B. Cleaning shall be done in accordance with manufacturer's recommendation.
- C. Cleaning shall be done in a manner and using such materials as to not damage the Work.
- D. Clean areas prior to painting or applying adhesive.
- E. Clean all heating and cooling systems prior to operations. If the Contractor is allowed to use the heating and cooling system, it shall be cleaned prior to testing.
- F. Clean all areas that will be concealed prior to concealment.
- G. Dispose of all fluids according to the approved Washing Plan.

### **3.02 FINAL CLEANING**

- A. Refer to Article, Clean-up Upon Completion in the General Contract Conditions, 2011 Edition. Additionally, the Contractor, shall at a minimum, complete the following:
  - 1. Inspect interior and exterior surfaces, including concealed spaces, in preparation for completion and acceptance.
  - 2. Remove dirt, dust, litter, corrosion, solvents, discursive paint, stains, and extraneous markings.
  - 3. Remove surplus materials, except those materials intended for maintenance.
  - 4. Remove all tools, appliances, equipment, and temporary facilities used in the construction.
  - 5. Remove detachable labels and tags. File them with the manufacturer's specifications for that specific material for the City's records.
  - 6. Repair damaged materials to the specified finish or remove and replace.
  - 7. After all trades have completed their work and just before Final Acceptance, all catch basins, manholes, drains, strainers and filters shall be cleaned; roadway, driveways, floors, steps and walks shall be swept. Interior building areas shall be vacuum cleaned and mopped.
  - 8. Final cleanup applies to all areas, whether previously occupied and operational or not.
  - 9. Dispose of all fluids according to the approved Washing Plan.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

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**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017420**

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**SECTION 017515****SYSTEM STARTUP, TESTING AND TRAINING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Provide complete startup, testing, and operator training services to ensure operability of all systems supplied.
- B. Coordinate all start-up and testing with DEN's Commissioning consultant and/or DEN Asset Management through the DEN Project Manager.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures. Submit the following:
  - 1. Test procedures.
  - 2. Test reports.
  - 3. Training outline.
- B. Submit Qualification Data: For facilitator, instructor, and videographer.
- C. Attendance Record: For each training module submit the following:
  - 1. Module title
  - 2. Module description
  - 3. Length of instruction time
  - 4. Participant names
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

**1.04 QUALITY ASSURANCE**

- A. Facilitator Qualifications: A firm or individual experienced in training or educating personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required. Recordings shall be high-resolution 1080p with a minimum framerate of 60Hz

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- D. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Section 014510 "Contractor Quality Control". Review methods and procedures related to demonstration and training including, but not limited to, the following:
1. Inspect and discuss locations and other facilities required for instruction.
  2. Review and finalize instruction schedule and verify availability of educational materials, instructor's personnel, audiovisual equipment, and facilities needed to avoid delays. Ensure that students are notified at least 14 [insert other] days prior to the start of instruction.
  3. Review required content of instruction.
  4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

**1.05 COORDINATION**

- A. Coordinate instruction schedule with DEN's operations. Adjust schedule as required to minimize disrupting DEN's operations and to ensure availability of DEN's personnel. As required, include multiple classed to accommodate various shifts
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by DEN Project Manager.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 FIELD TESTS AND ADJUSTMENTS**

- A. All electrical and mechanical equipment including the interfaces with control systems and the communication system, and all alarm and operating modes for each piece of equipment, shall be tested by the Contractor to the satisfaction of the DEN Project Manager before any facility is put into operation. Tests shall be as specified herein and shall be made to determine whether the equipment has been properly assembled, aligned and connected. Any changes, adjustments, or replacements required to make the equipment operate as specified shall be carried out by the Contractor as part of the Work.
1. At least thirty (30) days before the time allowed in the construction schedule for commencing startup and testing procedures, the Contractor shall submit to the DEN Project Manager three (3) copies of the detailed procedures the Contractor proposes for testing and startup of all electrical and mechanical equipment. These procedures are submitted for review and acceptance by DEN.
  2. The Contractor's startup and testing procedures shall include detailed descriptions of all pre-operational hardware, electrical, mechanical and instrumentation used for testing work.
    - a. Each control device, item of electrical, mechanical and instrumentation equipment, and all control circuits shall be considered in the testing procedures which shall be designed in a logical sequence to ensure that all equipment has been properly serviced, aligned, connected, wired, calibrated and adjusted prior to operation.
    - b. Motors shall be tested in accordance with ANSI/IEEE Publication 112. The

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 01 – GENERAL REQUIREMENTS**  
**SECTION 017515 – SYSTEM STARTUP, TESTING**  
**AND TRAINING**

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Contractor is advised that failure to observe these precautions may place the acceptability of the subject equipment in question, and the Contractor may either be required to demonstrate that the equipment has not been damaged, or replace it as determined by the DEN Project Manager.

3. Testing procedures shall be designed to duplicate as nearly as possible all conditions of operations and shall be carefully selected to ensure that the equipment is not damaged. All filters shall be in place during startup and testing.
    - a. Once the DEN Project Manager has accepted the testing procedures, the Contractor shall provide checkout, alignment, adjustment and calibration signoff forms for each item of equipment and each system that will be used.
    - b. The Contractor and the DEN Project Manager shall use the signoff forms in the field jointly to ensure that each item of electrical, mechanical and instrumentation equipment and each system has been properly installed and tested. The Contractor shall cooperate with project-wide systems contractors where startup and testing is to be conducted concurrently.
  4. Any special equipment needed to test equipment shall be provided by the Contractor to the City at no cost for a period of thirty (30) days during startup.
- B. Before starting up the equipment, the Contractor shall properly service it and other items, which normally require service in accordance with the maintenance instructions. The Contractor shall be responsible for lubrication and maintenance of equipment and replacement filters throughout the entire equipment “break-in” period described by the manufacturer.
1. The Contractor shall be responsible for the startup, adjustment, preliminary maintenance, and checkout of all equipment and instrumentation. All systems shall be carefully checked for conformance with the design criteria.
  2. If any equipment or system does not operate as specified in the Contract, the Contractor shall immediately replace or repair components until it operates properly.
  3. The Contractor shall submit a test report to the DEN Project Manager within thirty (30) days after completion of the system startup period.

**3.02 SYSTEMS STARTUP AND TESTING**

- A. The Contractor shall be responsible for a 30-day startup period during which time all hardware, electrical and mechanical equipment, communications, alarm systems, and associated devices shall be energized and operated under local and automatic controls. The Contractor shall be present during the startup period with adequate labor and support personnel to adjust equipment and troubleshoot system failures that might arise.
- B. When a piece of electrical or mechanical equipment is found to be in conflict with specific criteria, an experienced representative of the manufacturer shall adjust the item.
- C. If adjustments fail to correct the operation of a piece of equipment or fixture, the Contractor shall remove the equipment or fixture from the Project site and replace it with a workable replacement that meets the specification requirements.
- D. The 30-day startup period shall commence thirty (30) days prior to the Contract completion date and shall be completed prior to final payment. If, during the startup, any system fails to operate in accordance with Contract requirements, the failure shall be corrected and the startup period shall begin again.
  1. At the end of the startup period, all filters shall be replaced with new ones.
  2. The City may provide, at its option, a Commissioning Representative to observe or participate in the startup and testing of any system. The Contractor shall coordinate

with the Commissioning Representative relating to scheduling, reporting, forms, methods, and procedures of the startup and testing.

### **3.03 FINAL INSTRUCTIONS AND OPERATION TRAINING**

- A. After startup and testing is completed, the Contractor shall demonstrate to the City's personnel the proper manner of operating the equipment, programming messages, making adjustments, responding to alarms and emergency signals, and maintaining the system.
- B. The Contractor shall provide on-the-job training by a suitably qualified instructor to designated personnel and shall instruct them in the operation and maintenance of the systems. In the event qualified instructors on the Contractor's staff are not available, the Contractor shall arrange with the equipment manufacturer for such instruction at no additional cost to the City.
- C. The Contractor shall provide a minimum of eight (8) hours of operator training to the Airport per shift. Classes shall accommodate up to five (5) people at a time with up to two (2) separate courses (one for each shift).
- D. The Contractor shall provide a syllabus to the DEN Project Manager at least seven (7) calendar days prior to the start of each course that outlines topics to be covered, the proposed time allotted to each topic, and the target audience of the training session (technical, casual operator, overview, etc.). The Contractor shall not commence any training courses until the syllabus has been reviewed and approved by the DEN Project Manager.
- E. The Contractor shall video record all training sessions and provide to the DEN Project Manager. The Contractor shall provide video recordings in format as required in Section 017900 "Demonstration and Training".
- F. The Contractor shall provide an annotated syllabus to the DEN Project Manager that indicates topics contained on each tape.
- G. The contractor shall provide instruction for obtaining live help for questions relating operation and troubleshooting.

## **PART 4 - MEASUREMENT**

### **4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### **5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017515**

**SECTION 017720**  
**CONTRACT CLOSEOUT**

**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Special Sections, apply to this Section.

**1.02 SUMMARY**

- A. Work specified in this Section includes procedures required prior to Final Acceptance of the Work in addition to those specified in Title 20 – Final Completion and Acceptance of The Work in the General Contract Conditions, 2011 Edition, and Technical Specification Section 017840 "Contract Record Documents".
- B. This Section also includes procedures and penalties to ensure prompt completion of the Project Closeout.
- C. Related Sections:
1. Title 20 of the General Contract Conditions, 2011 Edition..
  2. Section 017840 "Contract Record Documents" for required record documents.
  3. Form CM-75, Closeout Checklist
- D. SUBMITTALS
1. Submit written Certification to the DEN Project Manager that, in the opinion of the Contractor, the Work is complete.
  2. Submit final survey within 60 days after issuance of Substantial Completion.
  3. Submit a Final Statement of Accounting to the DEN Project Manager.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PREPARATION FOR FINAL INSPECTION**

- A. Before requesting inspection for Final Acceptance of the Work by the City, the Contractor shall inspect, clean, and repair the Work as required.
- B. The Contractor shall ensure that all items on the Closeout Checklist have been addressed and accepted by the DEN Project Manager.

**3.02 FINAL INSPECTION**

- A. The Contractor shall submit written certification to the DEN Project Manager when, in the opinion of the Contractor, the Work is complete. Such communication shall certify that:
1. The Work has been inspected by the Contractor for conformance with the Contract Documents.

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2. The Work has been completed in conformance with the Contract Documents, including all punchlist items.
  3. The Work is ready for final inspection by the City.
  4. All as-built documents have been submitted and accepted.
  5. All damaged or destroyed real, personal, public, or private property impacted by the Work has been repaired or replaced.
  6. All Warranties and Bonds have been completed, executed, submitted, and accepted.
  7. All personnel badges and vehicle permits have been returned to DEN Airport Security.
- B. The DEN Project Manager will inspect the Work in accordance with the Section 2002.1 of the City and County of Denver's Department of Aviation's General Contract Conditions.
- C. If the DEN Project Manager finds incomplete or defective Work:
1. The DEN Project Manager may, at the DEN Project Manager's sole discretion, either terminate the inspection, or prepare a punchlist and notify the Contractor in writing, listing the incomplete or defective Work.
  2. The Contractor shall take immediate steps to remedy all identified deficiencies and resubmit a written certification to the DEN Project Manager that Work is complete.
  3. The DEN Project Manager will then re-inspect the Work.

### 3.03 REINSPECTION FEES

- A. Should the DEN Project Manager be required to perform re-inspections of the Work due to the Contractor prematurely claiming the status of the Work to be complete:
1. The Contractor shall compensate the City for such additional services at the per-hour rates defined below, for the time spent by the DEN Project Manager on re-inspection and related work, with a minimum charge of \$250:

<b>Position</b>	<b>Rate</b>
Project Manager	\$150
Quality Assurance Inspector	\$125
Commissioning Agent	\$125

2. The City shall deduct the amount of such compensation from the final payment to the Contractor.

### 3.04 FINAL SURVEY FEES

- A. The Contractor shall complete and submit the final survey within 60 days after issuance of Substantial Completion. If the Contractor fails to complete and submit the final survey within this time frame it is understood that DEN will arrange for a qualified surveying company to complete this work at the Contractor's expense. All costs associated with DEN arranging for and completing the final survey will be deducted from the final payment including compensation due the City for the DEN Project Manager's time to manage this work.
1. The DEN Project Manager's rate of compensation shall be set at \$150.00 per man-hour.
  2. Survey submittals needing to be revised may extend the 60-day time frame at the DEN Project Manager's discretion.
  3. Costs, including the DEN Project Manager's, for the review of the resubmitted survey shall be deducted from the final payment.

**3.05 LATE CLOSEOUT FEES**

- A. Within 100 days after issuance of substantial completion, all documentation required by this Contract to achieve Project Closeout shall be submitted. Failure to submit all required documentation shall result in fees to compensate the City for project management work while the project remains open. These shall be assessed if no liquidated damages are provided or and paid for late completion.
1. Fees at the rate of \$450 per day to compensate for additional DEN Project Manager, consultant, and other personnel's work.
  2. The resubmittal of required documents may extend the 100-day time frame at the DEN Project Manager's discretion.

**3.06 FINAL ADJUSTMENT OF ACCOUNTS**

- A. Submit a Final Statement of Accounting to the DEN Project Manager.
- B. The Final Statement of Accounting shall reflect all adjustments to the Contract amount and shall include the following:
1. The original Contract Value.
  2. Additions and deductions resulting from the following:
    - a. Approved Change Orders.
    - b. Allowances.
    - c. Final quantities for unit price items, including required backup for the quantities.
    - d. Deductions for corrected work.
    - e. Penalties.
    - f. Deductions for liquidated damages.
    - g. Deductions for re-inspection payments.
    - h. Other adjustments.
  3. Total Contract Value, as adjusted.
  4. Previous payments.
  5. Sum remaining due.
- C. If required, the DEN Project Manager will prepare a final Change Order, reflecting the approved adjustments to the Contract Value that were not included in previously issued Change Orders.

**3.07 FINAL APPLICATION FOR PAYMENT**

- A. The Contractor shall submit the final application for payment in accordance with the procedures and requirements detailed in Article 2003, Final Settlement in the General Contract Conditions, 2011 Edition.

**PART 4 - MEASUREMENT****4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

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**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017720**

**SECTION 017825****OPERATION AND MAINTENANCE DATA****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparing and submitting operation and maintenance data for mechanical, electrical, and other specified equipment/products.
- B. Coordinate all the requirements of the required data with DEN Asset Management.

**1.03 SUBMITTALS**

- A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
- B. All submittals must be provided in electronic data as indicated by the DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and as required by the DEN BIM and DEN Asset Management groups.
- C. Submit one (1) electronic copy and three (3) bound hard copies of the proposed Operation and Maintenance Data Manual not less than 30 days prior to acceptance tests and final inspection.
  - 1. The submitted copies shall provide the Information following the MasterFormat standard. Equipment/Data shall be organized using Section formatting within the 50 MasterFormat Divisions.
- D. Submit one (1) electronic copy and three (3) bound hard copies of Operation and Maintenance Data Manual within ten days after acceptance tests and final inspection is complete. These copies shall incorporate any comments made on the previous submittals, along with final readings on all settings and gauges taken while the system is in fully satisfactory operation.

**1.04 CONTINUOUS UPDATING PROGRAM**

- A. Furnish to DEN AIM Asset Management one (1) electronic copy of the Contractor's letter indicating that suppliers have been notified to provide updated operation and maintenance data, service bulletins, and other information pertinent to the equipment to DEN, as it becomes available.

**PART 2 - PRODUCTS****2.01 OPERATIONS AND MAINTENANCE MANUAL REQUIREMENTS**

- A. The following products are the requirements of hard copies:
  - 1. Paper size: 8-½ inches x 11 inches.

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2. Paper: White bond, at least 20-pound weight.
3. Text: Typewritten.
4. Printed data: Manufacturer's catalog cuts, brochures, operation, and maintenance data. Clear reproductions thereof will be acceptable. If this data is in color, all final manuals must contain color data.
5. Drawings: 8½ inches x 11 inches, bound with the text. Larger drawings are acceptable provided they are folded to fit into a pocket inside the rear cover of the manual. Reinforce edges of large drawings.
6. Prints of drawings: Black ink on white paper, sharp in detail and suitable for making reproductions.
7. Flysheets: Separate each portion of the manual with colored, neatly prepared flysheets briefly describing the contents of the ensuing portion.
8. Covers: Provide 40 to 50 mil, clear plastic, front and plain back covers for each manual. The front covers shall contain the information required in paragraph 3.2 below.
9. Bindings: Conceal the binding mechanism inside the manual. Lockable 3-ring binders shall be provided.
10. Training Videos: Provide in digital electronic format as per current DEN requirements.
  - a. Refer to Section 017900 - Demonstration and Training for video requirements.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Assemble each operation and maintenance manual using the manufacturer's latest standard commercial data, and include all additional information that is unique to the Project.

**3.02 COVER**

- A. Include the following information on the front cover and on the inside cover sheet:
  1. Operation and maintenance instructions.
  2. Title of structure or facility.
  3. Title and number of Contract.
  4. Contractor's name and address.
  5. General subject of the manual.

**3.03 CONTENTS OF THE MANUAL**

- A. Table of Contents, which references, at a minimum, three heading levels.
- B. Index of Equipment/Data with entries for equipment type and MasterFormat Division and Section.
- C. A Master Index that contains index entries for all submitted Operation and Maintenance Data Manuals.
  1. Equipment/Data shall be indexed by equipment type and MasterFormat Division and Section.

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2. Name, address, and telephone numbers of Contractor, suppliers and installers along with the manufacturer's order number and description of the order.
3. Name, address, and telephone numbers of manufacturer's nearest service representatives.
4. Name, address, and telephone number of nearest parts vendor and service agency.
5. Copy of guaranties and warranties issued to, and executed in the name of, the City.
6. Anticipated date the City assumes responsibility for maintenance.
7. Description of system and component parts including theory of operation.
8. Pre operation check or inspection list.
9. Procedures for starting, operating, and stopping equipment.
10. Post operation check or shutdown list.
11. Inspection and adjustment procedures.
12. Troubleshooting and fault isolation procedures for on-site level of repair.
13. Emergency operating instructions.
14. Accepted test data.
15. Maintenance schedules and procedures.
16. Test procedures to verify the adequacy of repairs.
17. One (1) copy of each wiring diagram.
18. One (1) copy of each piping diagram.
19. Location where all measurements are to be made.
20. One (1) copy of each duct diagram.
21. One (1) copy of control diagram.
22. One (1) copy of each accepted shop drawing.
23. One (1) copy of software programs imputable or changeable on site.
24. Ordering information.
25. Training course material used to train DEN staff, including slides and other presentation material.
26. Provide the following information, unless the item is covered in the Manufacturer's Operation and Manual:
  - a. Manufacturer's parts list with catalog names, numbers, and illustrations.
  - b. A list of components that are replaceable by the City.
  - c. An exploded view of each piece of the equipment with part designations.
  - d. List of manufacturer's recommended spare parts, current prices, and recommended quantities for two years of operation.
  - e. List of special tools and test equipment required for the operation, maintenance, adjustment, testing and repair of the equipment, instruments and components.
  - f. Scale and corrosion control procedures.
  - g. Disassembly and re-assembly instructions.
  - h. Troubleshooting and repair instructions.
  - i. Calibration procedures.

**PART 4 - MEASUREMENT**

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**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017825**

**SECTION 017835****WARRANTIES AND BONDS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of preparing and submitting warranties and bonds required by the Contract and these Specifications.

**1.03 SUBMITTALS**

- A. Refer to Technical Specifications Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
1. All warranties shall be executed or transmitted to the City and County of Denver.
  2. Photocopies or reproductions of stock manufacturer's warranties will not be accepted, although electronic copies are acceptable when the manufacturer's warranty is contained in the O&M manual.
- B. Submit samples of warranties and bonds for review by the City prior to execution of Work. Do not submit final warranties until sample warranties have been approved by the City.
1. Submit the warranties and bonds required by the Contract Documents.
  2. Prepare and submit a list of all warranties and bonds on the following forms:
    - a. CM-10: Contractor Warranty
    - b. CM-11: Contractor/Sub-Contractor Warranty
- C. Submit executed warranties and bonds.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 WARRANTIES AND BONDS**

- A. Submit executed warranties and bonds required by the Contract Documents, as detailed in Title 15 - Performance and Payment Bonds and Title 18 - Warranties, Guarantees, and Corrective Work in the General Contract Conditions, 2011 Edition.
1. Prepare and submit a list of all warranties and bonds on the following forms:
    - a. CM-10, Contractor Warranty
    - b. CM-11, Contractor/Sub-Contractor Warranty

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017835**

**SECTION 017840****CONTRACT RECORD DOCUMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. The Work specified in this Section consists of maintaining, marking, recording, and submitting Contract Record Documents that include shop drawings, warranties, and contractor records. Creating and providing to DEN these documents are part of the Work and become part of the Contract Documents.
- B. Refer to DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and Approved BIM execution for data format and file types acceptable for different type of data.
- C. Related Requirements:
1. Section 013100 "Project Management and Coordination".
  2. Section 013223 "Construction Layout, As-built and Quantity Surveys".
  3. Section 013300 "Submittal Procedures".
  4. Section 013325 "Shop and Working Drawings, Product Data and Samples".
  5. Section 017720 "Contract Closeout".
  6. Section 017825 "Operation and Maintenance Data".

**1.03 SUBMITTALS**

- A. Each submittal of record documents shall contain the following information:
1. Date.
  2. Project title and numbers.
  3. Contractor's name and address.
  4. Title and number of each record document.
  5. Certification that each document as submitted is complete and accurate.
  6. Signature of the Contractor or the Contractor's authorized representative.
- B. At the completion of this Contract, deliver all record documents including the following:
1. As-built shop drawings, diagrams, illustrations, schedules, charts, brochures and other similar data.
  2. Warranties, guarantees, and bonds.
  3. Contract Documents.
  4. Contractor records.

- C. As-built Contract Drawings shall be submitted with each monthly progress payment application, and a complete set shall be submitted prior to final payment.
1. The Contractor shall provide a single electronic copy of each Contract drawing sheet which has been used to produce work during the payment period or work that payment is being requested on, which records the current as-built conditions of work, including the posting of any change orders or change directives not shown on the Contract Documents at the time of Contract signing.
    - a. The Contractor must show as-built work completed through the payment application date including but not limited to utilities, empty conduit, conduit for actual electrical lines, plumbing, HVAC, location of anchor bolts and support points for use by others.
    - b. The Contractor shall be liable for any costs incurred by the City or a third party due to errors or lack of information provided on the as-built drawings.
    - c. All markings on drawings shall be legible to identify the portion of work completed.
    - d. For projects utilizing BIM system by the Contractor or a consultant of the Contractor, all data formats shall be compatible and as approved by the BIM execution plan as required in the DEN BIM DSM.

#### **1.04 QUALITY CONTROL**

- A. Submit electronically scanned copies of all documents required by Chapter 17 "Special Inspection and Testing" of the International Building Code 2009 as amended by City and County of Denver 2011. Keep scale and clarify dimension where electronic copies are not as originally scaled and dimensioned.
- B. For projects utilizing BIM for Revit, follow approved BIM execution plan and DEN BIM DSM for record documents, formats, and quality control and assurance procedures.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.01 MAINTENANCE OF DOCUMENTS**

- A. The Contractor must follow all the procedures established in the Contract Documents and DEN BIM DSM.
- B. The Contractor shall maintain at the work site on a current basis one (1) record copy of all drawings, specifications, addenda, change orders, approved shop drawings, working drawings, product data and samples in good order and marked currently to record all changes made during construction.
- C. Maintain at the field office one copy of the following record documents:
  1. Contract Documents:
    - a. Contract Drawings with all clarifications, requests for information, directives, changes, and as-built conditions clearly posted.
    - b. Contract Specifications with all clarifications, requests for information, changes, directives and record of manufacturer actually used along with product trade name.
    - c. Reference Standards in accordance with Section 014225 "Referenced Standards".
    - d. Affirmative Action Plan and documents.

- e. One (1) set of drawings to record the following:
  - 1) Horizontal and vertical location of underground utilities affected by the Work.
  - 2) Location of internal utilities; include valves, controls, conduit, duct work, switches, pressure reducers, size reducers, transitions, crosses, tees, filters, motors, heaters, dampers, regulators, safety devices, sensors, access doors and appurtenances that are concealed in the construction shall be shown with dimensions given from a visible and recognizable reference to the item being located in all three dimensions. The drawings shall also reference the applicable submittal for the item being located.
  - 3) Field changes of dimensions and details including as-built elevations and location (station and offset).
  - 4) Details not on original Contract Drawings but obtained through requests for information or by other communications with the City.
2. Contractor Records:
  - a. Daily Quality Control Reports.
  - b. Certificates of compliance for materials used in construction.
  - c. Completed inspection list.
  - d. Inspection and test reports.
  - e. Test procedures.
  - f. Qualification of personnel.
  - g. Approved submittals.
  - h. Material and equipment storage records.
  - i. Safety Plan
  - j. Erosion, sediment, hazardous and quality plans.
  - k. Hazardous material records.
  - l. First report of injuries.

### **3.02 RECORDINGS**

- A. Label each document page or article "PROJECT RECORD" in two-inch high letters.
- B. Keep record documents current daily.
- C. Legibly mark copies of the Contract Drawings to record actual construction.
- D. Legibly mark up each Section of the specifications and Contract Drawings to record:
  1. Manufacturer, trade name, catalog number and supplier of each product and item actually installed
  2. Changes made by change orders, requests for information, substitutions, and variations approved by submittals.

### **3.03 DOCUMENT MAINTENANCE**

- A. Follow all the required processes of the approved BIM Execution Plan as approved by DEN for this specific project or in formats acceptable to DEN BIM management system.
- B. Do not use record documents for construction purposes.
- C. Make documents available for inspection by the DEN Project Manager and any others having jurisdiction.

### **3.04 MONTHLY REVIEW**

- A. Prior to any application for payment, the DEN Project Manager or the DEN Project Manager's designated representative will inspect the record documents to ensure that they are being maintained and contain the most current correct data with particular attention to as-built drawings.
  
- A. If, during the inspection, the DEN Project Manager determines that the documents are not being maintained and kept current so they reflect as-built conditions, an amount may be withheld from the payment request and deducted from the Contract value to cover the City's cost of collecting, creating, and recording the as-built data. This cost will be determined based on \$100.00 per man-hour of effort.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017840**

**SECTION 017900****DEMONSTRATION AND TRAINING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section includes administrative and procedural requirements for instructing City's personnel, including the following:
1. Demonstration of operation of systems, subsystems, and equipment.
  2. Training in operation and maintenance of systems, subsystems, and equipment.
  3. Demonstration and training video recordings.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructor's names for each training module. Include learning objective and outline for each training module.
1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator, instructor, and videographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

**1.04 CLOSEOUT SUBMITTALS**

- A. Demonstration and Training Video Recordings: Submit two (2) copies within seven (7) days of end of each training module.
1. Identification: On each copy, provide an applied label with the following information:
    - a. Name of Project.
    - b. Name and address of videographer.
    - c. Name of Architect.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Date of video recording.
  2. Closed Caption: Videos shall contain a visible text version of all speech provided in the recording.

3. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
4. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
5. At completion of training, submit complete training manual(s) for City's use in PDF electronic file format.

### **1.05 QUALITY ASSURANCE**

- A. Facilitator Qualifications: A firm or individual experienced in training or educating personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A professional instructor/trainer who is experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Section 014510 "Contractor Quality Control". Review methods and procedures related to demonstration and training including, but not limited to, the following:
  1. Inspect and discuss locations and other facilities required for instruction.
  2. Review and finalize instruction schedule and verify availability of educational materials, instructor's personnel, audiovisual equipment, and facilities needed to avoid delays.
  3. Review required content of instruction.
  4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

### **1.06 COORDINATION**

- A. Coordinate instruction schedule with City's operations. Adjust schedule as required to minimize disrupting City's operations and to ensure availability of City's personnel.
  1. Include multiple classes to accommodate various shifts, as necessary.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by DEN Project Manager.

## **PART 2 - PRODUCTS**

### **2.01 INSTRUCTION PROGRAM**

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- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project record documents.
    - e. Identification systems.
    - f. Warranties and bonds.
    - g. Maintenance service agreements and similar continuing commitments.
  3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.
    - c. Shutdown instructions for each type of emergency.
    - d. Operating instructions for conditions outside of normal operating limits.
    - e. Sequences for electric or electronic systems.
    - f. Special operating instructions and procedures.
  4. Operations: Include the following, as applicable:
    - a. Startup procedures.
    - b. Equipment or system break-in procedures.
    - c. Routine and normal operating instructions.
    - d. Regulation and control procedures.
    - e. Control sequences.
    - f. Safety procedures.
    - g. Instructions on stopping.
    - h. Normal shutdown instructions.
    - i. Operating procedures for emergencies.
    - j. Operating procedures for system, subsystem, or equipment failure.
    - k. Seasonal and weekend operating instructions.
    - l. Required sequences for electric or electronic systems.
    - m. Special operating instructions and procedures.

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5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

**PART 3 - EXECUTION****3.01 PREPARATION**

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017825 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

**3.02 INSTRUCTION**

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and City for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct City's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  1. Contractor will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
  2. City will furnish an instructor to describe City's operational philosophy.
  3. DEN Project Manager will furnish Contractor with names and positions of DEN participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires

seasonal operation, provide similar instruction at start of each season.

1. Schedule training with City, through DEN Project Manager, with at a minimum of thirty (30) days advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test, as applicable and as required by the DEN PM.
- F. Cleanup: Collect used and leftover educational materials and give to DEN. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

### **3.03 DEMONSTRATION AND TRAINING VIDEO RECORDINGS**

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video Recordings: Submit video recordings in an electronic format acceptable to DEN Project Manager by posting to Project Web site. Recordings shall be high-resolution 1080p with a minimum framerate of 60Hz
1. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
  2. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project:
    - a. Name of Contractor/Installer.
    - b. Business address.
    - c. Business phone number.
    - d. Point of contact.
    - e. E-mail address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.
    - a. Produce segments to present a single significant piece of equipment per segment.
    - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.

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- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
1. Closed Caption: Videos shall contain a visible text version of all speech provided in the recording.
  2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
  3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Failure of Video Recordings: If video recordings submitted by Contractor do not comply with Project requirements, or have audio and/or video problems, Contractor will be required to repeat training and video recording in compliance with this Section in order to re-create the training video.

**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 017900**

**SECTION 019113****GENERAL COMMISSIONING REQUIREMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Basis of Design (BOD) documentation included by reference for information only.
- C. Specification Sections:
  - 1. Section 013100 – Project Management and Coordination
  - 2. Section 013119 – Project Meetings
  - 3. Section 013300 – Submittal Procedures
  - 4. Section 014510 – Contractor Quality Control
  - 5. Section 221323 – Sanitary Waste Interceptors
  - 6. Section 333123 – Sanitary Sewerage Force Main Piping

**1.02 SUMMARY**

- A. Scope
  - 1. Commissioning requirements common to all Sections
  - 2. Systems and equipment functional performance testing
  - 3. Validation of proper and thorough installation of systems and equipment
  - 4. Equipment performance verification
  - 5. Documentation of tests, procedures, and observations.
  - 6. Review of DEN Training agency.
- B. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

**1.03 DEFINITIONS**

- A. Acceptance Phase: The phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and formal training occurs. This will generally occur after the Construction Phase is complete (start-up and checks have been accomplished). The Acceptance Phase typically begins with Substantial Completion and ends with Final I Completion.
- B. Basis of Design (BOD): A document that records concepts, calculations, decisions, and product selections used to meet the Contract and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- C. Commissioning Authority (CA or CxA): The Party retained by DEN who will oversee the

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- Commissioning process as well as develop and stipulate many of the Commissioning requirements. They will also manage the Commissioning process, and ensure and validate that systems and equipment are designed, installed, and tested to meet DEN's requirements.
- D. Commissioning Contact (CxC): Individuals, appointed by the installing contractor, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action.
- E. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- F. Construction Phase: Phase of the project during which the facility is constructed and/or systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete start-up documentation, submit operation and maintenance information, establish trends, and perform any other applicable requirements to get systems started. Contractor and Vendors may also conduct equipment specific training. The Construction Phase will generally end upon Substantial Completion.
- G. Contractor: As used herein, 'Contractor' is a general reference to the installing Party and can therefore refer to the General Contractor, subcontractors, or vendors as inferred by its usage.
- H. Deficiency: A condition in the installation or function of a component, piece of equipment or system that does not comply with the Contract Documents, i.e., does not perform properly or is not complying with the design intent.
- I. Energy Management Control System (EMCS): The computer-based heating, ventilation, and air-conditioning (HVAC) control system.
- J. Factory Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.
- K. Factory Testing: Testing of equipment off-site at the manufacturer's facility. The testing may be witnessed by the members of the project team.
- L. Functional Performance Testing (FPT): The detailed and thorough testing of building systems and their interactions with building components and other building systems.
- M. Issue Log: This list is maintained and updated by the Commissioning Authority that includes all Issue items that relate to Commissioning activities and site observations requiring contractor action or response.
- N. Maximum Failure Limit: The maximum percentage of a test population that is permitted to fail before the test is considered a failure and subject to correction and retesting. Where test sampling is used, the Maximum Failure Limit shall be the maximum percentage of a test sample that is permitted to fail before an entirely new sample must be selected for testing.
- O. Operation and Maintenance (O&M) Documentation: Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. This includes manufacturer's literature (including O&M manuals, parts lists, troubleshooting guides, etc.), Contractor-developed instructions for start-up and shut-down, control sequences, and other installation-specific information.
- P. Pre-Start Up: Preliminary testing accomplished during a scheduled system outage to verify system functionality prior to placing the system/equipment into preliminary service.

- Q. Start-Up: Refers to the quality control process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the Start-Up Checklist, energizes the device, verifies that it is in proper working order and ready for dynamic testing, including Start-Up Tests.
- R. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- S. Test, Adjust, and Balance (TAB): Refers to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor.
- T. Trending: Monitoring and recording a history of parameters typically using the EMCS.

#### **1.04 ACTION SUBMITTALS**

- A. General requirements:
  - 1. Provide individual checklists and procedures for each system or component.
  - 2. Develop individual checklists and procedures for each tagged piece of equipment. General procedures developed for multiple pieces of equipment, including similar equipment, are not acceptable.
  - 3. Procedures and checklists for specified phases of commissioning (e.g. Pre-startup, startup, functional performance testing) must be submitted and approved prior to commencement of the related activity.
- B. CxA submittals:
  - 1. Commissioning plan.
  - 2. Pre-functional checklists: For each system or component.
  - 3. Startup procedures: For each system or component.
  - 4. Startup checklists: For each system or component.
  - 5. Completed startup checklists: For each system or component.
  - 6. Functional Test Procedures: For each system or component.
  - 7. Functional Test Checklists: For each system or component.
  - 8. Formal acceptance recommendation for each component or system tested, following successful completion of testing.
- C. Contractor submittals:
  - 1. Completed pre-functional checklists: For each system or component.
  - 2. Completed startup checklists: For each system or component.
  - 3. Completed functional test checklists: For each system or component.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. CxA submittals:
  - 1. Qualifications: For CxA and testing technicians.
  - 2. Test equipment calibration certificates.
  - 3. Preliminary Commissioning Report, including the following:

- a. Compiled test results.
  - b. Updated Issues Log.
  - c. Updated Checklist log.
4. Final Commissioning Report, including the following:
- a. Compiled test results.
  - b. Seasonal test results.
  - c. Warranty walkthrough results.
  - d. Completed issues log.
  - e. Completed checklist log.

### **1.06 COMMISSIONING TEAM**

- A. Members Appointed by Contractor(s):
1. Contractor shall appoint a CxC.
  2. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by DEN Project Manager:
1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. DEN will engage the CxA under a separate contract.
  2. Representatives of DEN Sustainability, DEN Project Manager Representative, and DEN Maintenance personnel.
  3. Architect and engineering design professionals.

### **1.07 DEN'S RESPONSIBILITIES**

- A. Assign DEN Sustainability and Operations Maintenance personnel and schedule them to participate in commissioning team activities.
- B. Coordinate activities specified in paragraph below with DOR and Architect-Consultant agreements.
- C. Provide the BoD documentation, prepared by DOR, and approved by DEN, to the CxA and [each ]Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

### **1.08 CONTRACTOR'S RESPONSIBILITIES**

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Include Commissioning requirements in price and plan for work.
  2. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
  3. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
  4. Attend commissioning team meetings held on a weekly basis and progressing to weekly meetings as construction project nears completion.

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5. Integrate and coordinate commissioning process activities with construction schedule.
  6. Review and accept construction pre-functional checklists provided by the CxA prior to commencing functional testing.
  7. Complete electronic construction checklists as Work is completed and provide to the DEN Project Manager after each checklist has been completed.
  8. Review and accept commissioning process functional test procedures provided by the Commissioning Authority.
  9. Designate a CxC from each major subcontractor with activities related to commissioning. These CxCs are to be the primary contacts for Commissioning activities.
  10. Contractor shall incorporate the Commissioning process into the construction schedule, outlining generic Commissioning tasks with precedents or prerequisites to each task. These tasks will apply to many systems and the Contractor shall incorporate as such. Examples of enumerated tasks include, but are not limited to:
    - a. Contractor preparation of the Training Plan
    - b. Testing Agency activities
    - c. Contractor documentation of pipe pressure testing, flushing, and cleaning of applicable systems
    - d. Documentation of the Start-Up Procedures for equipment and systems
    - e. TAB of applicable system
    - f. Preparation of the O&M Manual content
    - g. FPT and Acceptance
    - h. Observation Period and System Optimization
    - i. Occupant or other Regulatory Agency testing or approval process
  11. Assist the CxA in preparation for the specific FPT procedures. Contractors, subcontractors, and vendors shall review the FPTs to ensure feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures that is the result of malfunctioning equipment or contract deficiencies, shall be the responsibility of the Contractor.
  12. Record start-up and testing procedures.
  13. Demonstrate the operation of all systems as specified.
    - a. Operate systems, with assistance of DEN Maintenance, under direction of the CxA during FPT's and other acceptance testing.
- B. Acceptance Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.
1. Work in conjunction with CxA in FPT and shall include, but not limited to the following:
    - a. Operate and Manipulate systems and equipment to facilitate testing (as dictated in this section, relevant technical sections and the Commissioning Plan).
    - b. Operate and Manipulate EMCS and other control systems to facilitate FPT (as dictated in this section, relevant technical sections and the Commissioning Plan).
  2. Correct any work not in accordance with Contract Documents.
  3. Maintain record documentation and update and resubmit it after Functional Completion.
  4. Compensate DEN for additional CxA fees and expenses incurred to retest equipment and systems following testing failures.

5. Monitor systems, equipment, and areas throughout the Transition Period. Log and diagnose all alarms during this period. Maintain trends and logs of all critical parameters. Forward the logs and trends on a weekly basis throughout all Transition Periods.
- C. Warranty Period: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Warranty Period.
1. Provide warranty service
  2. Conduct EMCS Sequence Training
  3. Respond to and document Warranty issues
  4. Correct any deficiencies identified throughout the Warranty Period
  5. Update record documentation to reflect any changes made throughout the Warranty Period and resubmit final Record Drawings and data records at the close of the Warranty period

### **1.09 CXA'S RESPONSIBILITIES**

- A. Organize and lead the commissioning team through the entire project.
- B. Provide and update construction phase commissioning plans.
- C. Convene commissioning team meetings to discuss commissioning activities and current issues and resolutions.
- D. Provide Project-specific construction checklists and commissioning process test procedures.
- E. Review all pertinent equipment submittals, shop drawings, and O&M documentation.
- F. Verify the execution of commissioning process activities. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the DPR. When a requirement is not met, the CxA will report the failure in the Issues Log.
- G. Prepare and maintain the Issues Log.
- H. Prepare and maintain completed construction checklist log.
- I. Organize and lead the functional, seasonal, any LEED required tests, and 10-month Warranty review in the presence of the contractor, DEN Maintenance, and DEN PM assigned personnel.
- J. Witness systems, assemblies, equipment, and component startup.
- K. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

### **1.10 ISSUES LOG**

- A. CxA shall maintain an Issues Log (required information, identified deficiencies, work required, etc.) that relates to Commissioning. Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.

- B. CxA will provide this list to the DEN Project Manager during regular project meetings as appropriate to keep all parties informed.
- C. All parties indicated as responsible for an action item shall respond to the DEN Project Manager. Responses are due within 10 days of action items being identified to the team.

### **1.11 PRE-START UP**

#### **A. PREREQUISITES**

- 1. All equipment, components, and devices applicable to the Pre-Start Up must be installed, and the Pre-Start Up must be documented and approved. This includes installation, identification labeling, insulation, and all other requirements for placing systems into dynamic operation.

#### **B. COMMON ELEMENTS**

- 1. Required submittal documentation shall be present and located convenient to testing area.
- 2. Contractor shall submit the completed Pre-Start Up Procedures at least 10 days prior to the start of Functional testing. CxA shall review the Pre-Start Up Procedure documentation at the beginning of Start Up. Contractor shall demonstrate to DEN Project Manager, DEN Maintenance and DEN Sustainability that access is sufficient to perform required maintenance.
- 3. System and equipment configurations shall be compared against the contract documents.

### **1.12 INSTRUMENTATION**

- A. All test instruments described in this section shall be acceptable for any portion of the commissioning process herein described.
- B. All instruments shall conform to the standards specified in the most recent edition of “NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems” regarding accuracy and calibration status. Current calibration certificates must be available to the CxA if requested.
- C. Test instrument accuracy and resolution must match or exceed that of the system component being verified or calibrated.
- D. Test instruments must be used within guidelines as recommended by instrument manufacturer. All measuring methods must be appropriate to the instrument application and measurements must be repeatable under equivalent conditions.
- E. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis shall be provided by testing entity. These include, but are not limited to:
  - 1. Electronic Manometer (for Air and Flow Hood)
  - 2. Electronic Manometer (for Water)
  - 3. Temperature Instruments
  - 4. Pressure instruments
  - 5. Humidity Instruments
  - 6. CO2 Instrument

7. Sound Meter
8. Electronic Multimeter
9. Tachometer
10. Ultrasonic Flow Meter
11. Others as required

### **1.13 START-UP**

#### **A. Prerequisites**

1. All equipment, components, and devices applicable to the FPT must be started, and the Start-Up must be documented and approved. This includes completion of Start-Up Procedures, pressure testing (of equipment, duct and piping), flushing/cleaning, identification labeling, insulation, and all other requirements for placing systems into dynamic operation.
2. Unless specifically agreed to by DEN and CxA, all support systems shall be complete prior to FPT.
3. The CxA shall determine the optimal sequence of testing.

#### **B. Common Elements**

1. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and [complete] per the contract requirements.
2. Contractor shall provide the completed Start-Up Procedures at the time of testing. CxA shall review the Start-Up Procedure documentation and spot-check at the beginning of FPT.

#### **C. Procedure**

1. Purpose:
  - a. Verify adherence to, and documentation of, quality control processes involved with preparing systems and equipment for operation.
  - b. These procedures shall be performed on all installed systems and equipment and no sampling strategy is used for the start-up process.
  - c. The Commissioning process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment.
  - d. After the procedures are established, the Contractor performs them and documents them with the Start-up Procedures that are developed by the Contractor.
2. Start-Up Procedures: The content of these Start-Up Procedures shall provide the minimally acceptable content in accordance with the OEM field quality control requirements. Generic refers to the fact that the protocols may be created before the shop drawings are finalized. These procedures and protocols will normally be common across different manufacturers.
3. Content of Start-Up Procedures: Start-Up Procedures shall generally include the following for each item of equipment or system (as applicable):
  - a. Project-specific designation, location, and service.
  - b. Indication of the Party performing and documenting the Start-Up Procedure.
  - c. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail indication and a record of measure parameters.
  - d. A Start-up Checklist item indicating that proper maintenance clearances have

been maintained.

4. Recording and Documentation of Factory Start-Up: Manufacturer's start-up protocols shall be executed and forms shall be completed by a qualified/authorized technician.
5. Recording and Documentation of non-Factory Start-Up: The start-up tests and checklists shall be completed by a qualified technician.
6. Commissioning Authority Review: CxA will review and spot-check procedures during FPT.
7. Documentation Completion: The individual executing the start-up must complete the start-up and pre-functional documentation for any given equipment and acknowledge acceptability with the indication of who did the associated task.
8. Sampling and Final Submission: All (100% of) systems are started and documented per the approved procedures and NO sampling strategy is used. Completed Start-up and pre-functional checklists for all pieces of equipment associated with independent systems shall be submitted to CxA prior to any associated FPT. Any outstanding item shall be clearly indicated and an associated Action Item must be entered to track resolution.
9. DEN Access: Contractor shall allow access by DEN representatives to inspect the equipment and ensure its proper operation.

#### **1.14 TEST, ADJUST, AND BALANCE**

- A. CxA shall review TAB reports.
- B. The CxA shall select up to 10% of the readings from the Balancing Reports and verify performance readings. Readings selected by the CxA may include:
  1. Supply air diffuser readings (both minimum and maximum readings for variable air volume boxes).
  2. Main and branch supply duct traverse readings.
  3. Outside/return air flow readings.
  4. Exhaust airflow readings.
  5. Water flow readings.
  6. Ampere readings.
  7. Water pressure drop readings through coils, heat exchangers, and other hydronic elements.
- C. For all readings, a deviation of more than 10% between the verification reading and reported data shall be considered as failing the FPT. The maximum failure rate for the sample is 10%.
- D. If greater than 10% of sample readings have failed, the TAB contractor shall justify all noted failures or rebalance and re-document the system.

#### **1.15 FUNCTIONAL PERFORMANCE TESTING**

- A. Objectives and Scope
  1. Demonstrate that each system is operating according to the documented design intent and Contract Documents.
  2. Bring all commissioned systems from a state of substantial completion to full dynamic operation.

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3. Identify and correct performance deficiencies.
  4. Operate each system through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, normal and emergency power, fire alarm, part- and full-load) where there is a specified system response.
  5. Verify each sequence in the sequences of operation as required.
  6. Verify responses to abnormal operational modes and conditions, such as power failure, freeze conditions, no flow, equipment failure, etc.
- B. Development of Test Procedures
1. CxA shall develop specific test procedures to verify and document proper operation of each piece of equipment and system.
  2. CxA shall develop fill-in forms for use during FPT, based on the test procedures.
  3. Not less than 14 days prior to execution of FPT, CxA shall submit completed test procedures to the DEN Project Manager to review the tests for feasibility, safety, equipment and warranty protection, and scope.
  4. EMCS trends shall have been established as required in the documents. These shall generally be reviewed prior to or during FPT.
  5. Capacities and adjusted/balanced conditions as applicable shall be subject to review.
  6. Sequencing Verification: For applicable systems and equipment, all modes of operation shall be verified for proper sequencing.
  7. System and equipment configurations shall be compared against the contract documents.
  8. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe, and stable operation.
- C. Scheduling:
1. Contractor shall notify the CxA and the DEN Project Manager that systems are ready for testing, to schedule FPT.
  2. To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.
- D. Phasing:
1. Non-interdependent segments of the project testing may be phased.
  2. Phasing of FPT for this project shall be coordinated between the CxA, Contractor, and the DEN Project Manager as the project progresses.
- E. Participation:
1. CxA shall witness and document FPTs performed by the contractor after Start-Up Procedure documentation of systems and equipment has been reviewed and accepted.
  2. Contractor shall perform the FPTs as described, with manipulation of the systems or equipment, provision of supporting equipment or materials (lifts, ladders, specialty test equipment, safety equipment), and on-the-spot remediation of minor identified deficiencies whenever possible.
  3. Required participating Parties shall be indicated in the test plan for each individual FPT.

4. Required participating parties shall be available on-site throughout the testing of any given system for which they are required participants.
  5. CxA shall coordinate effectively with the individual Contractors throughout FPT and minimize their required involvement.
- F. Completeness:
1. All systems must be completed and ready for FPT at the time of the test.
  2. All start up, factory authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and operational for the respective system or component.
- G. Test Documentation:
1. CxA shall witness and document the tests.
  2. CxA shall record all test results on the forms developed for the testing.
  3. CxA shall 'Pass' or 'Fail' the testing and record the date and time of the test.
  4. Deficiencies shall be clearly indicated when the test is failed.
  5. When all related testing is completed successfully, CxA shall recommend acceptance of the system or component.
  6. In the case of specialized testing, CxA shall witness and review the testing reports prepared by the Contractor.
- H. Acceptance Criteria
1. The Acceptance Criteria shall be as follows unless specifically indicated within applicable individual specification sections or test procedures.
    - a. Accuracy/repeatability on sensing devices will be as specified for the device. CxA and TAB will use calibrated gauges for independent validation of sensing devices.
    - b. HVAC sequence-related criteria will be as specified in the documents.
- I. Deficiencies
1. CxA shall record the results of each functional test. All deficiencies or non-conformance issues shall be brought to Contractor's attention immediately, noted in the Issues Log, and reported to the DEN Project Manager within 72 hours.
    - a. Corrections of identified minor deficiencies may be made during the tests where feasible. In such cases, the deficiency will be noted on the FPT documents.
    - b. Deficiencies with potential schedule or cost impacts shall be reported to the DEN Project Manager within 24 hours of discovery.
  2. Contractor shall correct all identified deficiencies as directed by the DEN Project Manager.
    - a. CxA shall maintain Contractor's response to each deficiency in the Issues Log.
    - b. Contractor shall correct each deficiency, and notify CxA upon completion by completing an action item response.
    - c. Contractor shall schedule repeat testing and ensure CxA is available to observe.
  3. Disputes:
    - a. Contractor shall notify the DEN Project Manager and CxA immediately if the responsibility or nature of any identified deficiency is in dispute.
    - b. The CxA shall document as a disputed deficiency in the Issues Log.
    - c. The Contractor shall negotiate a resolution to the dispute with the DEN Project

- Manager.
- d. Upon resolution, CxA shall update the Issues Log to reflect the status of the deficiency
- J. Sampling Percentage:
1. Sampling percentage shall be as indicated in the test plan.
  2. Where no sampling percentage is indicated, the implied sampling percentage is 100% and all units shall be tested.
- K. Maximum Failure Limit:
1. Maximum Failure Limit shall be as indicated in the test plan.
  2. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.
  3. If no Maximum Failure Limit is indicated, the implied failure limit is 0% and all tested samples must pass.
  4. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems), the Maximum Failure Limit will apply per system.
  5. The responsible Contractors shall reimburse DEN for the CxA's cost of that sample test, and redo the start-up and TAB for the applicable devices/systems.
  6. All work necessitated by sample failures shall be at no cost to DEN.
- L. Manufacturer's Defects:
1. If 10% of identical pieces of equipment fail to perform to the Contract Documents (mechanically or substantively) due to a manufacturing defect, all identical units may be considered unacceptable by the DEN Project Manager.
  2. For the purposes of defining 'identical equipment' for this Section, size or capacity alone does not constitute a difference.
  3. In case of failure due to manufacturer's defects, the Contractor shall provide DEN with the following:
    - a. Manufacturer's response in writing as to the cause of the failure and proposed resolution.
    - b. Manufacturer shall implement their proposed resolution on a representative sample of the product.
    - c. The DEN Project Manager will determine whether a replacement of all identical units or a repair is acceptable.
    - d. Upon acceptance, the Contractor shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
    - e. Manufacturer shall pay the costs of all retesting necessitated by the failure.

## **1.16 CLOSEOUT**

- A. Commissioning Report
1. A final summary report by the CxA shall be provided to the DEN Project Manager, focusing on evaluating commissioning process issues and identifying areas where the process could be improved.
  2. Include all acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., compiled in appendices, and provided with the summary report.

3. Pre-Start Up verification, Start Up checklists, TAB, functional tests, and monitoring reports shall not be included in the final report, but shall be submitted as part of the Commissioning Record in the O&M manuals.
- B. Logs
1. CxA shall submit an updated Issues Log and all Issues Logs upon substantial completion of the project.
- C. Acceptance
1. CxA shall recommend acceptance of each test in writing to the DEN Project Manager.
  2. The CxA shall note each satisfactorily demonstrated function on the test documentation.
  3. Tests shall be considered accepted only upon formal acceptance by the DEN Project Manager.
- D. Training
1. The Contractor shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
  2. The CxA shall witness the content and adequacy of the training of DEN personnel for commissioned equipment. Any issues shall be noted in the Issues Log and reported immediately to the DEN Project Manager.
- E. Operation and Maintenance Manual and Record Drawing Review
1. Prior to substantial completion, the CxA shall review the O&M manuals, documentation, and redlined as-built drawings for systems that were commissioned to verify compliance with the Specifications.
  2. The CxA shall review completed record drawings and document any discrepancies in the Issues Log.

## **1.17 WARRANTY PERIOD**

- A. Warranty Walkthrough
1. General Requirements
    - a. Contractor and CxA, as directed by the DEN Project Manager, shall participate in an on-site walkthrough to review the condition of the project prior to expiration of the Contractor's warranty (the "warranty walkthrough").
    - b. The warranty walkthrough shall occur not less than nine (9) months following substantial completion, and not more than eleven (11) months following substantial completion.
    - c. Any deficiencies identified during the warranty walkthrough shall be identified and tracked using the Issues Log, and shall be provided in writing to the DEN Project Manager.
  2. Required Attendees:
    - a. Installing Contractor, and subcontractor representatives.
    - b. TAB Contractor.
    - c. CxA.
    - d. DEN Project Manager, or authorized representative.
    - e. DEN Asset Manager, or authorized representative.
  3. Contractor's Responsibilities

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- a. Contractor shall provide personnel at the warranty walkthrough as necessary to facilitate operation of equipment and testing procedures. Confirm with the DEN Project Manager a full list of attendees with their contact information not less than (4) weeks prior to scheduled warranty walkthrough. Required attendees shall include:
    - 1) Contractor's Project Manager.
    - 2) Manufacturer's representative(s) for commissioned equipment.
    - 3) Electrical Subcontractor.
    - 4) Mechanical Subcontractor.
    - 5) Others, as required by the DEN project Manager.
  - b. Contractor, or designated subcontractor or manufacturer's representative under direction of Contractor, shall operate equipment during the warranty walkthrough as directed by the DEN Project Manager.
4. CxA's Responsibilities
- a. CxA, under direction from the DEN Project Manager and DEN Asset Management, shall facilitate the inspection and verification of all commissioned systems as part of the on-site warranty walkthrough.
  - b. CxA shall perform visual inspection of equipment to document any warranty-related defects or damage.
  - c. CxA shall perform basic functional verification of equipment to affirm the equipment is operating in compliance with Contract Documents.
  - d. The CxA shall document any deficiencies found during the warranty walkthrough in the Issues Log and notify the DEN Project Manager.
  - e. Required documentation:
    - 1) Not less than (4) weeks prior to the scheduled warranty walkthrough, submit a warranty inspection checklist, including:
      - a) A section for each individual piece of equipment.
      - b) Expected attendees and responsibilities.
      - c) Fields or checkboxes for each individual inspection procedure or measurement as directed by the DEN Project Manager.
    - 2) CxA shall provide the approved warranty inspection checklist for use on-site at the warranty walkthrough.
    - 3) CxA shall provide the current Issues Log for use on-site at the warranty walkthrough.
    - 4) CxA shall provide an updated Issues Log to the DEN Project Manager following completion of the warranty walkthrough.
- B. Seasonal Testing
1. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract.
  2. The CxA shall coordinate this activity with the DEN Project Manager and the Contractor.
  3. Tests will be executed, documented and deficiencies corrected by the appropriate parties, with DEN maintenance staff and the CxA witnessing.
  4. Any final adjustments to the O&M manuals and Record Drawings due to the testing will be made by the responsible parties.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)**

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**PART 4 - MEASUREMENT**

**4.01 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

**5.01 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

**END OF SECTION 019113**

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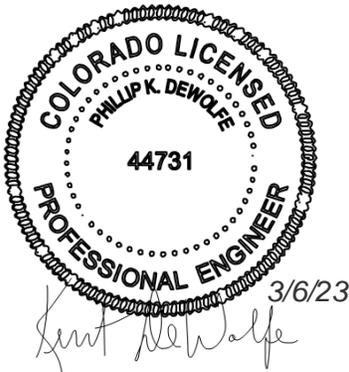
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FAA General Provisions  
& FAA Tech Specs (Civil)



MEP CSI Specs



Electrical Specs



# PROJECT MANUAL

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## VOLUME II

TECHNICAL SPECIFICATIONS

ISSUED FOR CONSTRUCTION

MARCH 06, 2023

CITY & COUNTY OF DENVER

DEPARTMENT OF AVIATION

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**END OF SECTION**

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### Section 10 Definition of Terms

When the following terms are used in these specifications, in the contract, or in any documents or other instruments pertaining to construction where these specifications govern, the intent and meaning shall be defined as follows:

Paragraph Number	Term	Definition
10-01	<b>AASHTO</b>	The American Association of State Highway and Transportation Officials.
10-02	<b>Access Road</b>	The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public roadway.
10-03	<b>Advertisement</b>	A public announcement, as required by local law, inviting bids for work to be performed and materials to be furnished.
10-04	<b>Airport</b>	Airport means an area of land or water which is used or intended to be used for the landing and takeoff of aircraft; an appurtenant area used or intended to be used for airport buildings or other airport facilities or rights of way; airport buildings and facilities located in any of these areas, and a heliport.
10-05	<b>Airport Improvement Program (AIP)</b>	A grant-in-aid program, administered by the Federal Aviation Administration (FAA).
10-06	<b>Air Operations Area (AOA)</b>	The term air operations area (AOA) shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operation area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.
10-07	<b>Apron</b>	Area where aircraft are parked, unloaded or loaded, fueled and/or serviced.
10-08	<b>ASTM International (ASTM)</b>	Formerly known as the American Society for Testing and Materials (ASTM).

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<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
<b>10-09</b>	<b>Award</b>	The Owner's notice to the successful bidder of the acceptance of the submitted bid.
<b>10-10</b>	<b>Bidder</b>	Any individual, partnership, firm, or corporation, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated.
<b>10-11</b>	<b>Building Area</b>	An area on the airport to be used, considered, or intended to be used for airport buildings or other airport facilities or rights-of-way together with all airport buildings and facilities located thereon.
<b>10-12</b>	<b>Calendar Day</b>	Every day shown on the calendar.
<b>10-13</b>	<b>Certificate of Analysis (COA)</b>	The COA is the manufacturer's Certificate of Compliance (COC) including all applicable test results required by the specifications.
<b>10-14</b>	<b>Certificate of Compliance (COC)</b>	The manufacturer's certification stating that materials or assemblies furnished fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer's authorized representative.
<b>10-15</b>	<b>Change Order</b>	A written order to the Contractor covering changes in the plans, specifications, or proposal quantities and establishing the basis of payment and contract time adjustment, if any, for work within the scope of the contract and necessary to complete the project.
<b>10-16</b>	<b>Contract</b>	<p>A written agreement between the Owner and the Contractor that establishes the obligations of the parties including but not limited to performance of work, furnishing of labor, equipment and materials and the basis of payment.</p> <p>The awarded contract includes but may not be limited to: Advertisement, Contract form, Proposal, Performance bond, payment bond, General provisions, certifications and representations, Technical Specifications, Plans, Supplemental Provisions, standards incorporated by reference and issued addenda.</p>
<b>10-17</b>	<b>Contract Item (Pay Item)</b>	A specific unit of work for which a price is provided in the contract.

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Paragraph Number	Term	Definition
10-18	<b>Contract Time</b>	The number of calendar days or working days, stated in the proposal, allowed for completion of the contract, including authorized time extensions. If a calendar date of completion is stated in the proposal, in lieu of a number of calendar or working days, the contract shall be completed by that date.
10-19	<b>Contractor</b>	The individual, partnership, firm, or corporation primarily liable for the acceptable performance of the work contracted and for the payment of all legal debts pertaining to the work who acts directly or through lawful agents or employees to complete the contract work.
10-20	<b>Contractors Quality Control (QC) Facilities</b>	The Contractor's QC facilities in accordance with the Contractor Quality Control Program (CQCP).
10-21	<b>Contractor Quality Control Program (CQCP)</b>	Details the methods and procedures that will be taken to assure that all materials and completed construction required by the contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors.
10-22	<b>Control Strip</b>	A demonstration by the Contractor that the materials, equipment, and construction processes results in a product meeting the requirements of the specification.
10-23	<b>Construction Safety and Phasing Plan (CSPP)</b>	The overall plan for safety and phasing of a construction project developed by the airport operator, or developed by the airport operator's consultant and approved by the airport operator. It is included in the invitation for bids and becomes part of the project specifications.
10-24	<b>Drainage System</b>	The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the airport area.
10-25	<b>Engineer</b>	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for engineering, inspection, and/or observation of the contract work and acting directly or through an authorized representative.

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Paragraph Number	Term	Definition
10-26	Equipment	All machinery, together with the necessary supplies for upkeep and maintenance; and all tools and apparatus necessary for the proper construction and acceptable completion of the work.
10-27	Extra Work	An item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, but which is found by the Owner's Engineer or Resident Project Representative (DEN PM) to be necessary to complete the work within the intended scope of the contract as previously modified.
10-28	FAA	The Federal Aviation Administration. When used to designate a person, FAA shall mean the Administrator or their duly authorized representative.
10-29	Federal Specifications	The federal specifications and standards, commercial item descriptions, and supplements, amendments, and indices prepared and issued by the General Services Administration.
10-30	Force Account	<p><b>a.</b> Contract Force Account - A method of payment that addresses extra work performed by the Contractor on a time and material basis.</p> <p><b>b.</b> Owner Force Account - Work performed for the project by the Owner's employees.</p>
10-31	Intention of Terms	<p>Whenever, in these specifications or on the plans, the words "directed," "required," "permitted," "ordered," "designated," "prescribed," or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer and/or Resident Project Representative (DEN PM) is intended; and similarly, the words "approved," "acceptable," "satisfactory," or words of like import, shall mean approved by, or acceptable to, or satisfactory to the Engineer and/or DEN PM, subject in each case to the final determination of the Owner.</p> <p>Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard shall be interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference.</p>

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Paragraph Number	Term	Definition
10-32	<b>Lighting</b>	A system of fixtures providing or controlling the light sources used on or near the airport or within the airport buildings. The field lighting includes all luminous signals, markers, floodlights, and illuminating devices used on or near the airport or to aid in the operation of aircraft landing at, taking off from, or taxiing on the airport surface.
10-33	<b>Major and Minor Contract Items</b>	A major contract item shall be any item that is listed in the proposal, the total cost of which is equal to or greater than 20% of the total amount of the award contract. All other items shall be considered minor contract items.
10-34	<b>Materials</b>	Any substance specified for use in the construction of the contract work.
10-35	<b>Modification of Standards (MOS)</b>	Any deviation from standard specifications applicable to material and construction methods in accordance with FAA Order 5300.1.
10-36	<b>Notice to Proceed (NTP)</b>	A written notice to the Contractor to begin the actual contract work on a previously agreed to date. If applicable, the Notice to Proceed shall state the date on which the contract time begins.
10-37	<b>Owner</b>	The term "Owner" shall mean the party of the first part or the contracting agency signatory to the contract. Where the term "Owner" is capitalized in this document, it shall mean airport Sponsor only. The Owner for this project is <u>the city and county of Denver</u> .
10-38	<b>Passenger Facility Charge (PFC)</b>	Per 14 Code of Federal Regulations (CFR) Part 158 and 49 United States Code (USC) § 40117, a PFC is a charge imposed by a public agency on passengers enplaned at a commercial service airport it controls.
10-39	<b>Pavement Structure</b>	The combined surface course, base course(s), and subbase course(s), if any, considered as a single unit.
10-40	<b>Payment bond</b>	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will pay in full all bills and accounts for materials and labor used in the construction of the work.

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<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
<b>10-41</b>	<b>Performance bond</b>	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will complete the work in accordance with the terms of the contract.
<b>10-42</b>	<b>Plans</b>	The official drawings or exact reproductions which show the location, character, dimensions and details of the airport and the work to be done and which are to be considered as a part of the contract, supplementary to the specifications. Plans may also be referred to as 'contract drawings.'
<b>10-43</b>	<b>Project</b>	The agreed scope of work for accomplishing specific airport development with respect to a particular airport.
<b>10-44</b>	<b>Proposal</b>	The written offer of the bidder (when submitted on the approved proposal form) to perform the contemplated work and furnish the necessary materials in accordance with the provisions of the plans and specifications.
<b>10-45</b>	<b>Proposal guaranty</b>	The security furnished with a proposal to guarantee that the bidder will enter into a contract if their own proposal is accepted by the Owner.
<b>10-46</b>	<b>Quality Assurance (QA)</b>	Owner's responsibility to assure that construction work completed complies with specifications for payment.
<b>10-47</b>	<b>Quality Control (QC)</b>	Contractor's responsibility to control material(s) and construction processes to complete construction in accordance with project specifications.
<b>10-48</b>	<b>Quality Assurance (QA) Inspector</b>	An authorized representative of the Engineer and/or Resident Project Representative (DEN PM) assigned to make all necessary inspections, observations, tests, and/or observation of tests of the work performed or being performed, or of the materials furnished or being furnished by the Contractor.
<b>10-49</b>	<b>Quality Assurance (QA) Laboratory</b>	The official quality assurance testing laboratories of the Owner or such other laboratories as may be designated by the Engineer or DEN PM. May also be referred to as Engineer's, Owner's, or QA Laboratory.

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<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
<b>10-50</b>	<b>DEN Project Manager (DEN PM)</b>	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for all necessary inspections, observations, tests, and/or observations of tests of the contract work performed or being performed, or of the materials furnished or being furnished by the Contractor, and acting directly or through an authorized representative.
<b>10-51</b>	<b>Runway</b>	The area on the airport prepared for the landing and takeoff of aircraft.
<b>10-52</b>	<b>Runway Safety Area (RSA)</b>	A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to aircraft. See the construction safety and phasing plan (CSPP) for limits of the RSA.
<b>10-53</b>	<b>Safety Plan Compliance Document (SPCD)</b>	Details how the Contractor will comply with the CSPP.
<b>10-54</b>	<b>Specifications</b>	A part of the contract containing the written directions and requirements for completing the contract work. Standards for specifying materials or testing which are cited in the contract specifications by reference shall have the same force and effect as if included in the contract physically.
<b>10-55</b>	<b>Sponsor</b>	A Sponsor is defined in 49 USC § 47102(24) as a public agency that submits to the FAA for an AIP grant; or a private Owner of a public-use airport that submits to the FAA an application for an AIP grant for the airport.
<b>10-56</b>	<b>Structures</b>	Airport facilities such as bridges; culverts; catch basins, inlets, retaining walls, cribbing; storm and sanitary sewer lines; water lines; underdrains; electrical ducts, manholes, handholes, lighting fixtures and bases; transformers; navigational aids; buildings; vaults; and, other manmade features of the airport that may be encountered in the work and not otherwise classified herein.
<b>10-57</b>	<b>Subgrade</b>	The soil that forms the pavement foundation.
<b>10-58</b>	<b>Superintendent</b>	The Contractor's executive representative who is present on the work during progress, authorized to

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Paragraph Number	Term	Definition
		receive and fulfill instructions from the DEN PM, and who shall supervise and direct the construction.
10-59	<b>Supplemental Agreement</b>	A written agreement between the Contractor and the Owner that establishes the basis of payment and contract time adjustment, if any, for the work affected by the supplemental agreement. A supplemental agreement is required if: (1) in scope work would increase or decrease the total amount of the awarded contract by more than 25%; (2) in scope work would increase or decrease the total of any major contract item by more than 25%; (3) work that is not within the scope of the originally awarded contract; or (4) adding or deleting of a major contract item.
10-60	<b>Surety</b>	The corporation, partnership, or individual, other than the Contractor, executing payment or performance bonds that are furnished to the Owner by the Contractor.
10-61	<b>Taxilane</b>	A taxiway designed for low speed movement of aircraft between aircraft parking areas and terminal areas.
10-62	<b>Taxiway</b>	The portion of the air operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways, aircraft parking areas, and terminal areas.
10-63	<b>Taxiway/Taxilane Safety Area (TSA)</b>	A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an aircraft. See the construction safety and phasing plan (CSPP) for limits of the TSA.
10-64	<b>Work</b>	The furnishing of all labor, materials, tools, equipment, and incidentals necessary or convenient to the Contractor's performance of all duties and obligations imposed by the contract, plans, and specifications.
10-65	<b>Working day</b>	A working day shall be any day other than a legal holiday, Saturday, or Sunday on which the normal working forces of the Contractor may proceed with regular work for at least six (6) hours toward completion of the contract. When work is suspended for causes beyond the Contractor's control, it will not be counted as a working day. Saturdays, Sundays

<b>Paragraph Number</b>	<b>Term</b>	<b>Definition</b>
		and holidays on which the Contractor's forces engage in regular work will be considered as working days.
<b>10-66</b>	<b>Owner Defined terms</b>	None

**END OF SECTION 10**

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## Section 20 Proposal Requirements and Conditions

**20-01 Advertisement (Notice to Bidders).** This project has been advertised on the DEN Contract Procurement Website. <http://business.flydenver.com/bizops/bids.asp>.

**20-02 Qualification of bidders.** Each bidder shall submit evidence of competency and evidence of financial responsibility to perform the work to the Owner at the time of bid opening.

Evidence of competency, unless otherwise specified, shall consist of statements covering the bidder's past experience on similar work, and a list of equipment and a list of key personnel that would be available for the work.

Each bidder shall furnish the Owner satisfactory evidence of their financial responsibility. Evidence of financial responsibility, unless otherwise specified, shall consist of a confidential statement or report of the bidder's financial resources and liabilities as of the last calendar year or the bidder's last fiscal year. Such statements or reports shall be certified by a public accountant. At the time of submitting such financial statements or reports, the bidder shall further certify whether their financial responsibility is approximately the same as stated or reported by the public accountant. If the bidder's financial responsibility has changed, the bidder shall qualify the public accountant's statement or report to reflect the bidder's true financial condition at the time such qualified statement or report is submitted to the Owner.

Unless otherwise specified, a bidder may submit evidence that they are prequalified with the State Highway Division and are on the current "bidder's list" of the state in which the proposed work is located. Evidence of State Highway Division prequalification may be submitted as evidence of financial responsibility in lieu of the certified statements or reports specified above.

**20-03 Contents of proposal forms.** The Owner's proposal forms state the location and description of the proposed construction; the place, date, and time of opening of the proposals; and the estimated quantities of the various items of work to be performed and materials to be furnished for which unit bid prices are asked. The proposal form states the time in which the work must be completed, and the amount of the proposal guaranty that must accompany the proposal. The Owner will accept only those Proposals properly executed on physical forms or electronic forms provided by the Owner. Bidder actions that may cause the Owner to deem a proposal irregular are given in paragraph 20-09 *Irregular proposals*.

Mobilization is limited to 10 percent of the total project cost.

A prebid conference is required on this project to discuss as a minimum, the following items: material requirements; submittals; Quality Control/Quality Assurance requirements; the construction safety and phasing plan including airport access and staging areas; and unique airfield paving construction requirements. See project advertisement for prebid information.

**20-04 Issuance of proposal forms.** The Owner reserves the right to refuse to issue a proposal form to a prospective bidder if the bidder is in default for any of the following reasons:

a. Failure to comply with any prequalification regulations of the Owner, if such regulations are cited, or otherwise included, in the proposal as a requirement for bidding.

**b.** Failure to pay, or satisfactorily settle, all bills due for labor and materials on former contracts in force with the Owner at the time the Owner issues the proposal to a prospective bidder.

**c.** Documented record of Contractor default under previous contracts with the Owner.

**d.** Documented record of unsatisfactory work on previous contracts with the Owner.

**20-05 Interpretation of estimated proposal quantities.** An estimate of quantities of work to be done and materials to be furnished under these specifications is given in the proposal. It is the result of careful calculations and is believed to be correct. It is given only as a basis for comparison of proposals and the award of the contract. The Owner does not expressly, or by implication, agree that the actual quantities involved will correspond exactly therewith; nor shall the bidder plead misunderstanding or deception because of such estimates of quantities, or of the character, location, or other conditions pertaining to the work. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications. It is understood that the quantities may be increased or decreased as provided in the Section 40, paragraph 40-02, Alteration of Work and Quantities, without in any way invalidating the unit bid prices.

**20-06 Examination of plans, specifications, and site.** The bidder is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, and contract forms. Bidders shall satisfy themselves to the character, quality, and quantities of work to be performed, materials to be furnished, and to the requirements of the proposed contract. The submission of a proposal shall be prima facie evidence that the bidder has made such examination and is satisfied to the conditions to be encountered in performing the work and the requirements of the proposed contract, plans, and specifications.

Boring logs and other records of subsurface investigations and tests are available for inspection of bidders. It is understood and agreed that such subsurface information, whether included in the plans, specifications, or otherwise made available to the bidder, was obtained and is intended for the Owner's design and estimating purposes only. Such information has been made available for the convenience of all bidders. It is further understood and agreed that each bidder is solely responsible for all assumptions, deductions, or conclusions which the bidder may make or obtain from their own examination of the boring logs and other records of subsurface investigations and tests that are furnished by the Owner.

**20-07 Preparation of proposal.** The bidder shall submit their proposal on the forms furnished by the Owner. All blank spaces in the proposal forms, unless explicitly stated otherwise, must be correctly filled in where indicated for each and every item for which a quantity is given. The bidder shall state the price (written in ink or typed) both in words and numerals which they propose for each pay item furnished in the proposal. In case of conflict between words and numerals, the words, unless obviously incorrect, shall govern.

The bidder shall correctly sign the proposal in ink. If the proposal is made by an individual, their name and post office address must be shown. If made by a partnership, the name and post office address of each member of the partnership must be shown. If made by a corporation, the person signing the proposal shall give the name of the state where the corporation was chartered and the name, titles, and business address of the president, secretary, and the treasurer. Anyone signing a proposal as an agent shall file evidence of their authority to do so and that the signature is binding upon the firm or corporation.

**20-08 Responsive and responsible bidder.** A responsive bid conforms to all significant terms and conditions contained in the Owner's invitation for bid. It is the Owner's responsibility to

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decide if the exceptions taken by a bidder to the solicitation are material or not and the extent of deviation it is willing to accept.

A responsible bidder has the ability to perform successfully under the terms and conditions of a proposed procurement, as defined in 2 CFR § 200.318(h). This includes such matters as Contractor integrity, compliance with public policy, record of past performance, and financial and technical resources.

**20-09 Irregular proposals.** Proposals shall be considered irregular for the following reasons:

- a. If the proposal is on a form other than that furnished by the Owner, or if the Owner's form is altered, or if any part of the proposal form is detached.
- b. If there are unauthorized additions, conditional or alternate pay items, or irregularities of any kind that make the proposal incomplete, indefinite, or otherwise ambiguous.
- c. If the proposal does not contain a unit price for each pay item listed in the proposal, except in the case of authorized alternate pay items, for which the bidder is not required to furnish a unit price.
- d. If the proposal contains unit prices that are obviously unbalanced.
- e. If the proposal is not accompanied by the proposal guaranty specified by the Owner.
- f. If the applicable Disadvantaged Business Enterprise information is incomplete.

The Owner reserves the right to reject any irregular proposal and the right to waive technicalities if such waiver is in the best interest of the Owner and conforms to local laws and ordinances pertaining to the letting of construction contracts.

**20-10 Bid guarantee.** Each separate proposal shall be accompanied by a bid bond, certified check, or other specified acceptable collateral, in the amount specified in the proposal form. Such bond, check, or collateral, shall be made payable to the Owner.

**20-11 Delivery of proposal.** Each proposal submitted shall be placed in a sealed envelope plainly marked with the project number, location of airport, and name and business address of the bidder on the outside. When sent by mail, preferably registered, the sealed proposal, marked as indicated above, should be enclosed in an additional envelope. No proposal will be considered unless received at the place specified in the advertisement or as modified by Addendum before the time specified for opening all bids. Proposals received after the bid opening time shall be returned to the bidder unopened.

**20-12 Withdrawal or revision of proposals.** A bidder may withdraw or revise (by withdrawal of one proposal and submission of another) a proposal provided that the bidder's request for withdrawal is received by the Owner in writing or by email before the time specified for opening bids. Revised proposals must be received at the place specified in the advertisement before the time specified for opening all bids.

**20-13 Public opening of proposals.** Proposals shall be opened, and read, publicly at the time and place specified in the advertisement. Bidders, their authorized agents, and other interested persons are invited to attend. Proposals that have been withdrawn (by written or telegraphic request) or received after the time specified for opening bids shall be returned to the bidder unopened.

**20-14 Disqualification of bidders.** A bidder shall be considered disqualified for any of the following reasons:

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a. Submitting more than one proposal from the same partnership, firm, or corporation under the same or different name.

b. Evidence of collusion among bidders. Bidders participating in such collusion shall be disqualified as bidders for any future work of the Owner until any such participating bidder has been reinstated by the Owner as a qualified bidder.

c. If the bidder is considered to be in “default” for any reason specified in paragraph 20-04, *Issuance of Proposal Forms*, of this section.

**20-15 Discrepancies and Omissions.** A Bidder who discovers discrepancies or omissions with the project bid documents shall immediately notify the Owner’s Engineer of the matter. A bidder that has doubt as to the true meaning of a project requirement may submit to the Owner’s Engineer a written request for interpretation no later than 7 days prior to bid opening.

Any interpretation of the project bid documents by the Owner’s Engineer will be by written addendum issued by the Owner. The Owner will not consider any instructions, clarifications or interpretations of the bidding documents in any manner other than written addendum.

**END OF SECTION 20**

## Section 30 Award and Execution of Contract

**30-01 Consideration of proposals.** After the proposals are publicly opened and read, they will be compared on the basis of the summation of the products obtained by multiplying the estimated quantities shown in the proposal by the unit bid prices. If a bidder's proposal contains a discrepancy between unit bid prices written in words and unit bid prices written in numbers, the unit bid price written in words shall govern.

Until the award of a contract is made, the Owner reserves the right to reject a bidder's proposal for any of the following reasons:

a. If the proposal is irregular as specified in Section 20, paragraph 20-09, *Irregular Proposals*.

b. If the bidder is disqualified for any of the reasons specified Section 20, paragraph 20-14, *Disqualification of Bidders*.

In addition, until the award of a contract is made, the Owner reserves the right to reject any or all proposals, waive technicalities, if such waiver is in the best interest of the Owner and is in conformance with applicable state and local laws or regulations pertaining to the letting of construction contracts; advertise for new proposals; or proceed with the work otherwise. All such actions shall promote the Owner's best interests.

**30-02 Award of contract.** The award of a contract, if it is to be awarded, shall be made within 90 calendar days of the date specified for publicly opening proposals, unless otherwise specified herein.

If the Owner elects to proceed with an award of contract, the Owner will make award to the responsible bidder whose bid, conforming with all the material terms and conditions of the bid documents, is the lowest in price.

**30-03 Cancellation of award.** The Owner reserves the right to cancel the award without liability to the bidder, except return of proposal guaranty, at any time before a contract has been fully executed by all parties and is approved by the Owner in accordance with paragraph 30-07 *Approval of Contract*.

**30-04 Return of proposal guaranty.** All proposal guaranties, except those of the two lowest bidders, will be returned immediately after the Owner has made a comparison of bids as specified in the paragraph 30-01, *Consideration of Proposals*. Proposal guaranties of the two lowest bidders will be retained by the Owner until such time as an award is made, at which time, the unsuccessful bidder's proposal guaranty will be returned. The successful bidder's proposal guaranty will be returned as soon as the Owner receives the contract bonds as specified in paragraph 30-05, *Requirements of Contract Bonds*.

**30-05 Requirements of contract bonds.** At the time of the execution of the contract, the successful bidder shall furnish the Owner a surety bond or bonds that have been fully executed by the bidder and the surety guaranteeing the performance of the work and the payment of all legal debts that may be incurred by reason of the Contractor's performance of the work. The surety and the form of the bond or bonds shall be acceptable to the Owner. Unless otherwise

specified in this subsection, the surety bond or bonds shall be in a sum equal to the full amount of the contract.

**30-06 Execution of contract.** The successful bidder shall sign (execute) the necessary agreements for entering into the contract and return the signed contract to the Owner, along with the fully executed surety bond or bonds specified in paragraph 30-05, *Requirements of Contract Bonds*, of this section, within 15 calendar days from the date mailed or otherwise delivered to the successful bidder.

**30-07 Approval of contract.** Upon receipt of the contract and contract bond or bonds that have been executed by the successful bidder, the Owner shall complete the execution of the contract in accordance with local laws or ordinances, and return the fully executed contract to the Contractor. Delivery of the fully executed contract to the Contractor shall constitute the Owner's approval to be bound by the successful bidder's proposal and the terms of the contract.

**30-08 Failure to execute contract.** Failure of the successful bidder to execute the contract and furnish an acceptable surety bond or bonds within the period specified in paragraph 30-06, *Execution of Contract*, of this section shall be just cause for cancellation of the award and forfeiture of the proposal guaranty, not as a penalty, but as liquidated damages to the Owner.

**END OF SECTION 30**

## Section 40 Scope of Work

**40-01 Intent of contract.** The intent of the contract is to provide for construction and completion, in every detail, of the work described. It is further intended that the Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

**40-02 Alteration of work and quantities.** The Owner reserves the right to make such changes in quantities and work as may be necessary or desirable to complete, in a satisfactory manner, the original intended work. Unless otherwise specified in the Contract, the Owner's Engineer or DEN PM shall be and is hereby authorized to make, in writing, such in-scope alterations in the work and variation of quantities as may be necessary to complete the work, provided such action does not represent a significant change in the character of the work.

For purpose of this section, a significant change in character of work means: any change that is outside the current contract scope of work; any change (increase or decrease) in the total contract cost by more than 25%; or any change in the total cost of a major contract item by more than 25%.

Work alterations and quantity variances that do not meet the definition of significant change in character of work shall not invalidate the contract nor release the surety. Contractor agrees to accept payment for such work alterations and quantity variances in accordance with Section 90, paragraph 90-03, *Compensation for Altered Quantities*.

Should the value of altered work or quantity variance meet the criteria for significant change in character of work, such altered work and quantity variance shall be covered by a supplemental agreement. Supplemental agreements shall also require consent of the Contractor's surety and separate performance and payment bonds. If the Owner and the Contractor are unable to agree on a unit adjustment for any contract item that requires a supplemental agreement, the Owner reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

**40-03 Omitted items.** The Owner, the Owner's Engineer or the DEN PM may provide written notice to the Contractor to omit from the work any contract item that does not meet the definition of major contract item. Major contract items may be omitted by a supplemental agreement. Such omission of contract items shall not invalidate any other contract provision or requirement.

Should a contract item be omitted or otherwise ordered to be non-performed, the Contractor shall be paid for all work performed toward completion of such item prior to the date of the order to omit such item. Payment for work performed shall be in accordance with Section 90, paragraph 90-04, *Payment for Omitted Items*.

**40-04 Extra work.** Should acceptable completion of the contract require the Contractor to perform an item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, Owner may issue a Change Order to cover the necessary extra work. Change orders for extra work shall contain agreed unit prices for performing the change order work in accordance with the requirements specified in the order, and shall contain any adjustment to the contract time that, in the DEN PM's opinion, is necessary for completion of the extra work.

When determined by the DEN PM to be in the Owner's best interest, the DEN PM may order the Contractor to proceed with extra work as provided in Section 90, paragraph 90-05, *Payment for Extra Work*. Extra work that is necessary for acceptable completion of the project, but is not within the general scope of the work covered by the original contract shall be covered by a supplemental agreement as defined in Section 10, paragraph 10-59, *Supplemental Agreement*.

If extra work is essential to maintaining the project critical path, DEN PM may order the Contractor to commence the extra work under a Time and Material contract method. Once sufficient detail is available to establish the level of effort necessary for the extra work, the Owner shall initiate a change order or supplemental agreement to cover the extra work.

Any claim for payment of extra work that is not covered by written agreement (change order or supplemental agreement) shall be rejected by the Owner.

**40-05 Maintenance of traffic.** It is the explicit intention of the contract that the safety of aircraft, as well as the Contractor's equipment and personnel, is the most important consideration. The Contractor shall maintain traffic in the manner detailed in the Construction Safety and Phasing Plan (CSPP).

a. It is understood and agreed that the Contractor shall provide for the free and unobstructed movement of aircraft in the air operations areas (AOAs) of the airport with respect to their own operations and the operations of all subcontractors as specified in Section 80, paragraph 80-04, *Limitation of Operations*. It is further understood and agreed that the Contractor shall provide for the uninterrupted operation of visual and electronic signals (including power supplies thereto) used in the guidance of aircraft while operating to, from, and upon the airport as specified in Section 70, paragraph 70-15, *Contractor's Responsibility for Utility Service and Facilities of Others*.

b. With respect to their own operations and the operations of all subcontractors, the Contractor shall provide marking, lighting, and other acceptable means of identifying personnel, equipment, vehicles, storage areas, and any work area or condition that may be hazardous to the operation of aircraft, fire-rescue equipment, or maintenance vehicles at the airport in accordance with the construction safety and phasing plan (CSPP) and the safety plan compliance document (SPCD).

c. When the contract requires the maintenance of an existing road, street, or highway during the Contractor's performance of work that is otherwise provided for in the contract, plans, and specifications, the Contractor shall keep the road, street, or highway open to all traffic and shall provide maintenance as may be required to accommodate traffic. The Contractor, at their expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel. The Contractor shall furnish, erect, and maintain barricades, warning signs, flag person, and other traffic control devices in reasonable conformity with the Manual on Uniform Traffic Control Devices (MUTCD) (<http://mutcd.fhwa.dot.gov/>), unless otherwise specified. The Contractor shall also construct and maintain in a safe condition any temporary connections necessary for ingress to and egress from abutting property or intersecting roads, streets or highways.

**40-06 Removal of existing structures.** All existing structures encountered within the established lines, grades, or grading sections shall be removed by the Contractor, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work or to remain in place. The cost of removing such existing structures shall not be measured or paid for directly, but shall be included in the various contract items.

Should the Contractor encounter an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the Resident Project Representative (DEN PM) shall be notified prior to disturbing such structure. The disposition of existing structures so encountered shall be immediately determined by the DEN PM in accordance with the provisions of the contract.

Except as provided in Section 40, paragraph 40-07, *Rights in and Use of Materials Found in the Work*, it is intended that all existing materials or structures that may be encountered (within the lines, grades, or grading sections established for completion of the work) shall be used in the work as otherwise provided for in the contract and shall remain the property of the Owner when so used in the work.

**40-07 Rights in and use of materials found in the work.** Should the Contractor encounter any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, the use of which is intended by the terms of the contract to be embankment, the Contractor may at their own option either:

- a. Use such material in another contract item, providing such use is approved by the DEN PM and is in conformance with the contract specifications applicable to such use; or,
- b. Remove such material from the site, upon written approval of the DEN PM; or
- c. Use such material for the Contractor's own temporary construction on site; or,
- d. Use such material as intended by the terms of the contract.

Should the Contractor wish to exercise option a., b., or c., the Contractor shall request the DEN PM's approval in advance of such use.

Should the DEN PM approve the Contractor's request to exercise option a., b., or c., the Contractor shall be paid for the excavation or removal of such material at the applicable contract price. The Contractor shall replace, at their expense, such removed or excavated material with an agreed equal volume of material that is acceptable for use in constructing embankment, backfills, or otherwise to the extent that such replacement material is needed to complete the contract work. The Contractor shall not be charged for use of such material used in the work or removed from the site.

Should the DEN PM approve the Contractor's exercise of option a., the Contractor shall be paid, at the applicable contract price, for furnishing and installing such material in accordance with requirements of the contract item in which the material is used.

It is understood and agreed that the Contractor shall make no claim for delays by reason of their own exercise of option a., b., or c.

The Contractor shall not excavate, remove, or otherwise disturb any material, structure, or part of a structure which is located outside the lines, grades, or grading sections established for the work, except where such excavation or removal is provided for in the contract, plans, or specifications.

**40-08 Final cleanup.** Upon completion of the work and before acceptance and final payment will be made, the Contractor shall remove from the site all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees. The Contractor shall cut all brush and woods within the limits indicated and shall leave the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property will not be considered as having been disposed of satisfactorily, unless the Contractor has obtained the written permission of the property Owner.

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**END OF SECTION 40**

## Section 50 Control of Work

**50-01 Authority of the DEN Project Manager (DEN PM).** The DEN PM has final authority regarding the interpretation of project specification requirements. The DEN PM shall determine acceptability of the quality of materials furnished, method of performance of work performed, and the manner and rate of performance of the work. The DEN PM does not have the authority to accept work that does not conform to specification requirements.

**50-02 Conformity with plans and specifications.** All work and all materials furnished shall be in reasonably close conformity with the lines, grades, grading sections, cross-sections, dimensions, material requirements, and testing requirements that are specified (including specified tolerances) in the contract, plans, or specifications.

If the DEN PM finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications, but that the portion of the work affected will, in their opinion, result in a finished product having a level of safety, economy, durability, and workmanship acceptable to the Owner, the DEN PM will advise the Owner of their determination that the affected work be accepted and remain in place. The DEN PM will document the determination and recommend to the Owner a basis of acceptance that will provide for an adjustment in the contract price for the affected portion of the work. Changes in the contract price must be covered by contract change order or supplemental agreement as applicable.

If the DEN PM finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor in accordance with the DEN PM's written orders.

The term "reasonably close conformity" shall not be construed as waiving the Contractor's responsibility to complete the work in accordance with the contract, plans, and specifications. The term shall not be construed as waiving the DEN PM's responsibility to insist on strict compliance with the requirements of the contract, plans, and specifications during the Contractor's execution of the work, when, in the DEN PM's opinion, such compliance is essential to provide an acceptable finished portion of the work.

The term "reasonably close conformity" is also intended to provide the DEN PM with the authority, after consultation with the Sponsor and FAA, to use sound engineering judgment in their determinations to accept work that is not in strict conformity, but will provide a finished product equal to or better than that required by the requirements of the contract, plans and specifications.

The DEN PM will not be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction or the safety precautions incident thereto.

**50-03 Coordination of contract, plans, and specifications.** The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. If electronic files are provided and used on the project and there is a conflict between the electronic files and hard copy plans, the hard copy plans shall govern. A

requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; contract technical specifications shall govern over contract general provisions, plans, cited standards for materials or testing, and cited advisory circulars (ACs); contract general provisions shall govern over plans, cited standards for materials or testing, and cited ACs; plans shall govern over cited standards for materials or testing and cited ACs. If any paragraphs contained in the Special Provisions conflict with General Provisions or Technical Specifications, the Special Provisions shall govern.

From time to time, discrepancies within cited testing standards occur due to the timing of the change, edits, and/or replacement of the standards. If the Contractor discovers any apparent discrepancy within standard test methods, the Contractor shall immediately ask the DEN PM for an inteDEN PMetation and decision, and such decision shall be final.

The Contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the Contractor discovers any apparent error or discrepancy, Contractor shall immediately notify the Owner or the designated representative in writing requesting their written interpretation and decision.

**50-04 List of Special Provisions.** Not used.

**50-05 Cooperation of Contractor.** The Contractor shall be supplied with an electronic PDF of the plans and specifications. The Contractor shall have available on the construction site at all times one hardcopy each of the plans and specifications. Additional hard copies of plans and specifications may be obtained by the Contractor for the cost of reproduction.

The Contractor shall give constant attention to the work to facilitate the progress thereof, and shall cooperate with the DEN PM and their inspectors and with other Contractors in every way possible. The Contractor shall have a competent superintendent on the work at all times who is fully authorized as their agent on the work. The superintendent shall be capable of reading and thoroughly understanding the plans and specifications and shall receive and fulfill instructions from the DEN PM or their authorized representative.

**50-06 Cooperation between Contractors.** The Owner reserves the right to contract for and perform other or additional work on or near the work covered by this contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct the work not to interfere with or hinder the progress of completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with their own contract and shall protect and hold harmless the Owner from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange their work and shall place and dispose of the materials being used to not interfere with the operations of the other Contractors within the limits of the same project. The Contractor shall join their work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

**50-07 Construction layout and stakes.** The Engineer/DEN PM shall establish necessary horizontal and vertical control. The establishment of Survey Control and/or reestablishment of survey control shall be by a State Licensed Land Surveyor. Contractor is responsible for preserving integrity of horizontal and vertical controls established by Engineer/DEN PM. In case

of negligence on the part of the Contractor or their employees, resulting in the destruction of any horizontal and vertical control, the resulting costs will be deducted as a liquidated damage against the Contractor.

Prior to the start of construction, the Contractor will check all control points for horizontal and vertical accuracy and certify in writing to the DEN PM that the Contractor concurs with survey control established for the project. All lines, grades and measurements from control points necessary for the proper execution and control of the work on this project will be provided to the DEN PM. The Contractor is responsible to establish all layout required for the construction of the project.

Copies of survey notes will be provided to the DEN PM for each area of construction and for each placement of material as specified to allow the DEN PM to make periodic checks for conformance with plan grades, alignments and grade tolerances required by the applicable material specifications. Surveys will be provided to the DEN PM prior to commencing work items that cover or disturb the survey staking. Survey(s) and notes shall be provided in the following format(s): electronic and hardcopies.)

Laser, GPS, String line, or other automatic control shall be checked with temporary control as necessary. In the case of error, on the part of the Contractor, their surveyor, employees or subcontractors, resulting in established grades, alignment or grade tolerances that do not concur with those specified or shown on the plans, the Contractor is solely responsible for correction, removal, replacement and all associated costs at no additional cost to the Owner.

No direct payment will be made, unless otherwise specified in contract documents, for this labor, materials, or other expenses. The cost shall be included in the price of the bid for the various items of the Contract.

**50-08 Authority and duties of Quality Assurance (QA) inspectors.** QA inspectors shall be authorized to inspect all work done and all material furnished. Such QA inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. QA inspectors are not authorized to revoke, alter, or waive any provision of the contract. QA inspectors are not authorized to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

QA Inspectors are authorized to notify the Contractor or their representatives of any failure of the work or materials to conform to the requirements of the contract, plans, or specifications and to reject such nonconforming materials in question until such issues can be referred to the DEN PM for a decision.

**50-09 Inspection of the work.** All materials and each part or detail of the work shall be subject to inspection. The DEN PM shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the DEN PM requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be at the Contractor's expense.

Provide advance written notice to the DEN PM of work the Contractor plans to perform each week and each day. Any work done or materials used without written notice and allowing opportunity for inspection by the DEN PM may be ordered removed and replaced at the Contractor's expense.

Should the contract work include relocation, adjustment, or any other modification to existing facilities, not the property of the (contract) Owner, authorized representatives of the Owners of such facilities shall have the right to inspect such work. Such inspection shall in no sense make any facility owner a party to the contract, and shall in no way interfere with the rights of the parties to this contract.

**50-10 Removal of unacceptable and unauthorized work.** All work that does not conform to the requirements of the contract, plans, and specifications will be considered unacceptable, unless otherwise determined acceptable by the DEN PM as provided in paragraph 50-02, *Conformity with Plans and Specifications*.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner in accordance with the provisions of Section 70, paragraph 70-14, *Contractor's Responsibility for Work*.

No removal work made under provision of this paragraph shall be done without lines and grades having been established by the DEN PM. Work done contrary to the instructions of the DEN PM, work done beyond the lines shown on the plans or as established by the DEN PM, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply with any order of the DEN PM made under the provisions of this subsection, the DEN PM will have authority to cause unacceptable work to be remedied or removed and replaced; and unauthorized work to be removed and recover the resulting costs as a liquidated damage against the Contractor.

**50-11 Load restrictions.** The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the work. A special permit will not relieve the Contractor of liability for damage that may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or to any other type of construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete pavement, base, or structure before the expiration of the curing period. The Contractor, at their own expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel.

**50-12 Maintenance during construction.** The Contractor shall maintain the work during construction and until the work is accepted. Maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the work is maintained in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various contract items, and the Contractor will not be paid an additional amount for such work.

**50-13 Failure to maintain the work.** Should the Contractor at any time fail to maintain the work as provided in paragraph 50-12, *Maintenance during Construction*, the DEN PM shall immediately notify the Contractor of such noncompliance. Such notification shall specify a reasonable time within which the Contractor shall be required to remedy such unsatisfactory maintenance condition. The time specified will give due consideration to the exigency that exists.

Should the Contractor fail to respond to the DEN PM's notification, the Owner may suspend any work necessary for the Owner to correct such unsatisfactory maintenance condition, depending on the exigency that exists. Any maintenance cost incurred by the Owner, shall be recovered as a liquidated damage against the Contractor.

**50-14 Partial acceptance.** If at any time during the execution of the project the Contractor substantially completes a usable unit or portion of the work, the occupancy of which will benefit the Owner, the Contractor may request the DEN PM to make final inspection of that unit. If the DEN PM finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, the DEN PM may accept it as being complete, and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance and beneficial occupancy by the Owner shall not void or alter any provision of the contract.

**50-15 Final acceptance.** Upon due notice from the Contractor of presumptive completion of the entire project, the DEN PM and Owner will make an inspection. If all construction provided for and contemplated by the contract is found to be complete in accordance with the contract, plans, and specifications, such inspection shall constitute the final inspection. The DEN PM shall notify the Contractor in writing of final acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the DEN PM will notify the Contractor and the Contractor shall correct the unsatisfactory work. Upon correction of the work, another inspection will be made which shall constitute the final inspection, provided the work has been satisfactorily completed. In such event, the DEN PM will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

**50-16 Claims for adjustment and disputes.** If for any reason the Contractor deems that additional compensation is due for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized as extra work, the Contractor shall notify the DEN PM in writing of their intention to claim such additional compensation before the Contractor begins the work on which the Contractor bases the claim. If such notification is not given or the DEN PM is not afforded proper opportunity by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor and the fact that the DEN PM has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the Contractor shall, within 10 calendar days, submit a written claim to the DEN PM who will present it to the Owner for consideration in accordance with local laws or ordinances.

Nothing in this subsection shall be construed as a waiver of the Contractor's right to dispute final payment based on differences in measurements or computations.

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 50 CONTROL OF WORK**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**END OF SECTION 50**

## Section 60 Control of Materials

**60-01 Source of supply and quality requirements.** The materials used in the work shall conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials that are manufactured or processed shall be new (as compared to used or reprocessed).

In order to expedite the inspection and testing of materials, the Contractor shall furnish documentation to the DEN PM as to the origin, composition, and manufacture of all materials to be used in the work. Documentation shall be furnished promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the DEN PM's option, materials may be approved at the source of supply before delivery. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources.

The Contractor shall furnish airport lighting equipment that meets the requirements of the specifications; and is listed in AC 150/5345-53, *Airport Lighting Equipment Certification Program and Addendum*, that is in effect on the date of advertisement.

**60-02 Samples, tests, and cited specifications.** All materials used in the work shall be inspected, tested, and approved by the DEN PM before incorporation in the work unless otherwise designated. Any work in which untested materials are used without approval or written permission of the DEN PM shall be performed at the Contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the DEN PM, shall be removed at the Contractor's expense.

Unless otherwise designated, quality assurance tests will be made by and at the expense of the Owner in accordance with the cited standard methods of ASTM, American Association of State Highway and Transportation Officials (AASHTO), federal specifications, Commercial Item Descriptions, and all other cited methods, which are current on the date of advertisement for bids.

The testing organizations performing on-site quality assurance field tests shall have copies of all referenced standards on the construction site for use by all technicians and other personnel. Unless otherwise designated, samples for quality assurance will be taken by a qualified representative of the DEN PM. All materials being used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. Copies of all tests will be furnished to the Contractor's representative at their request after review and approval of the DEN PM.

A copy of all Contractor QC test data shall be provided to the DEN PM daily, along with printed reports, in an approved format, on a weekly basis. After completion of the project, and prior to final payment, the Contractor shall submit a final report to the DEN PM showing all test data reports, plus an analysis of all results showing ranges, averages, and corrective action taken on all failing tests.

The Contractor shall employ a Quality Control (QC) testing organization to perform all Contractor required QC tests in accordance with Item C-100 Contractor Quality Control Program (CQCP).

**60-03 Certification of compliance/analysis (COC/COA).** The DEN PM may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's COC stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or assemblies delivered to the work must be accompanied by a certificate of compliance in which the lot is clearly identified. The COA is the manufacturer's COC and includes all applicable test results.

Materials or assemblies used on the basis of certificates of compliance may be sampled and tested at any time and if found not to be in conformity with contract requirements will be subject to rejection whether in place or not.

The form and distribution of certificates of compliance shall be as approved by the DEN PM.

When a material or assembly is specified by "brand name or equal" and the Contractor elects to furnish the specified "or equal," the Contractor shall be required to furnish the manufacturer's certificate of compliance for each lot of such material or assembly delivered to the work. Such certificate of compliance shall clearly identify each lot delivered and shall certify as to:

- a. Conformance to the specified performance, testing, quality or dimensional requirements; and,
- b. Suitability of the material or assembly for the use intended in the contract work.

The DEN PM shall be the sole judge as to whether the proposed "or equal" is suitable for use in the work.

The DEN PM reserves the right to refuse permission for use of materials or assemblies on the basis of certificates of compliance.

**60-04 Plant inspection.** The DEN PM or their authorized representative may inspect, at its source, any specified material or assembly to be used in the work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the work and to obtain samples required for acceptance of the material or assembly.

Should the DEN PM conduct plant inspections, the following conditions shall exist:

- a. The DEN PM shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.
- b. The DEN PM shall have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.
- c. If required by the DEN PM, the Contractor shall arrange for adequate office or working space that may be reasonably needed for conducting plant inspections. Place office or working space in a convenient location with respect to the plant.

It is understood and agreed that the Owner shall have the right to retest any material that has been tested and approved at the source of supply after it has been delivered to the site. The DEN PM shall have the right to reject only material which, when retested, does not meet the requirements of the contract, plans, or specifications.

**60-05 Engineer/ DEN Project Manager (DEN PM) field office.** An Engineer/DEN PM field office is not required.

**60-06 Storage of materials.** Materials shall be stored to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be

inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. The Contractor shall coordinate the storage of all materials with the DEN PM. Materials to be stored on airport property shall not create an obstruction to air navigation nor shall they interfere with the free and unobstructed movement of aircraft. Unless otherwise shown on the plans and/or CSPP, the storage of materials and the location of the Contractor's plant and parked equipment or vehicles shall be as directed by the DEN PM. Private property shall not be used for storage purposes without written permission of the Owner or lessee of such property. The Contractor shall make all arrangements and bear all expenses for the storage of materials on private property. Upon request, the Contractor shall furnish the DEN PM a copy of the property Owner's permission.

All storage sites on private or airport property shall be restored to their original condition by the Contractor at their expense, except as otherwise agreed to (in writing) by the Owner or lessee of the property.

**60-07 Unacceptable materials.** Any material or assembly that does not conform to the requirements of the contract, plans, or specifications shall be considered unacceptable and shall be rejected. The Contractor shall remove any rejected material or assembly from the site of the work, unless otherwise instructed by the DEN PM.

Rejected material or assembly, the defects of which have been corrected by the Contractor, shall not be returned to the site of the work until such time as the DEN PM has approved its use in the work.

**60-08 Owner furnished materials.** The Contractor shall furnish all materials required to complete the work, except those specified, if any, to be furnished by the Owner. Owner-furnished materials shall be made available to the Contractor at the location specified.

All costs of handling, transportation from the specified location to the site of work, storage, and installing Owner-furnished materials shall be included in the unit price bid for the contract item in which such Owner-furnished material is used.

After any Owner-furnished material has been delivered to the location specified, the Contractor shall be responsible for any demurrage, damage, loss, or other deficiencies that may occur during the Contractor's handling, storage, or use of such Owner-furnished material. The Owner will deduct from any monies due or to become due the Contractor any cost incurred by the Owner in making good such loss due to the Contractor's handling, storage, or use of Owner-furnished materials.

**END OF SECTION 60**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 60 CONTROL OF MATERIALS**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## **Section 70 Legal Regulations and Responsibility to Public**

**70-01 Laws to be observed.** The Contractor shall keep fully informed of all federal and state laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the Owner and all their officers, agents, or servants against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor's employees.

**70-02 Permits, licenses, and taxes.** The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful execution of the work.

**70-03 Patented devices, materials, and processes.** If the Contractor is required or desires to use any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the Patentee or Owner. The Contractor and the surety shall indemnify and hold harmless the Owner, any third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Owner for any costs, expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the execution or after the completion of the work.

**70-04 Restoration of surfaces disturbed by others.** The Owner reserves the right to authorize the construction, reconstruction, or maintenance of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA) facility, or a utility service of another government agency at any time during the progress of the work. To the extent that such construction, reconstruction, or maintenance has been coordinated with the Owner, such authorized work (by others) must be shown on the plans and is indicated as follows: See section 011810, Utilities Interface, subsection 1.2B for a listing of the applicable utility owners.

Except as listed above, the Contractor shall not permit any individual, firm, or corporation to excavate or otherwise disturb such utility services or facilities located within the limits of the work without the written permission of the DEN PM.

Should the Owner of public or private utility service, FAA, or NOAA facility, or a utility service of another government agency be authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the Contractor shall cooperate with such Owners by arranging and performing the work in this contract to facilitate such construction, reconstruction or maintenance by others whether or not such work by others is listed above. When ordered as extra work by the DEN PM, the Contractor shall make all necessary repairs to the work which are due to such authorized work by others, unless otherwise provided for in the contract, plans, or specifications. It is understood and agreed that the Contractor shall not be entitled to make any claim for damages due to such authorized work by others or for any delay to the work resulting from such authorized work.

**70-05 Federal Participation.** The United States Government has agreed to reimburse the Owner for some portion of the contract costs. The contract work is subject to the inspection and

approval of duly authorized representatives of the FAA Administrator. No requirement of this contract shall be construed as making the United States a party to the contract nor will any such requirement interfere, in any way, with the rights of either party to the contract.

**70-06 Sanitary, health, and safety provisions.** The Contractor's worksite and facilities shall comply with applicable federal, state, and local requirements for health, safety and sanitary provisions.

**70-07 Public convenience and safety.** The Contractor shall control their operations and those of their subcontractors and all suppliers, to assure the least inconvenience to the traveling public. Under all circumstances, safety shall be the most important consideration.

The Contractor shall maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to their own operations and those of their own subcontractors and all suppliers in accordance with Section 40, paragraph 40-05, *Maintenance of Traffic*, and shall limit such operations for the convenience and safety of the traveling public as specified in Section 80, paragraph 80-04, *Limitation of Operations*.

The Contractor shall remove or control debris and rubbish resulting from its work operations at frequent intervals, and upon the order of the DEN PM. If the DEN PM determines the existence of Contractor debris in the work site represents a hazard to airport operations and the Contractor is unable to respond in a prompt and reasonable manner, the DEN PM reserves the right to assign the task of debris removal to a third party and recover the resulting costs as a liquidated damage against the Contractor.

**70-08 Construction Safety and Phasing Plan (CSPP).** The Contractor shall complete the work in accordance with the approved Construction Safety and Phasing Plan (CSPP) developed in accordance with AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP is on the GC sheet(s) of the project plans.

**70-09 Use of explosives.** The use of explosives is not permitted on this project. DEN PM

**70-10 Protection and restoration of property and landscape.** The Contractor shall be responsible for the preservation of all public and private property, and shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer/DEN PM has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be responsible for all damage or injury to property of any character, during the execution of the work, resulting from any act, omission, neglect, or misconduct in manner or method of executing the work, or at any time due to defective work or materials, and said responsibility shall not be released until the project has been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof by the Contractor, the Contractor shall restore, at their expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner.

**70-11 Responsibility for damage claims.** The Contractor shall indemnify and hold harmless the Engineer/DEN PM and the Owner and their officers, agents, and employees from all suits, actions, or claims, of any character, brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any

infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, ordinance, order, or decree. Money due the Contractor under and by virtue of their own contract considered necessary by the Owner for such purpose may be retained for the use of the Owner or, in case no money is due, their own surety may be held until such suits, actions, or claims for injuries or damages shall have been settled and suitable evidence to that effect furnished to the Owner, except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he or she is adequately protected by public liability and property damage insurance.

**70-12 Third party beneficiary clause.** It is specifically agreed between the parties executing the contract that it is not intended by any of the provisions of any part of the contract to create for the public or any member thereof, a third-party beneficiary or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

**70-13 Opening sections of the work to traffic.** If it is necessary for the Contractor to complete portions of the contract work for the beneficial occupancy of the Owner prior to completion of the entire contract, such "phasing" of the work must be specified below and indicated on the approved Construction Safety and Phasing Plan (CSPP) and the project plans. When so specified, the Contractor shall complete such portions of the work on or before the date specified or as otherwise specified.

Refer to the phasing plans of the construction drawings. .

- **Required Date or Sequence of Owner's Beneficial Occupancy**
- **Work Shown on Plan Sheet**

Upon completion of any portion of work listed above, such portion shall be accepted by the Owner in accordance with Section 50, paragraph 50-14, *Partial Acceptance*.

No portion of the work may be opened by the Contractor until directed by the Owner in writing. Should it become necessary to open a portion of the work to traffic on a temporary or intermittent basis, such openings shall be made when, in the opinion of the DEN PM, such portion of the work is in an acceptable condition to support the intended traffic. Temporary or intermittent openings are considered to be inherent in the work and shall not constitute either acceptance of the portion of the work so opened or a waiver of any provision of the contract. Any damage to the portion of the work so opened that is not attributable to traffic which is permitted by the Owner shall be repaired by the Contractor at their expense.

The Contractor shall make their own estimate of the inherent difficulties involved in completing the work under the conditions herein described and shall not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work.

The Contractor must conform to safety standards contained AC 150/5370-2 and the approved CSPP.

Contractor shall refer to the plans, specifications, and the approved CSPP to identify barricade requirements, temporary and/or permanent markings, airfield lighting, guidance signs and other safety requirements prior to opening up sections of work to traffic.

**70-14 Contractor's responsibility for work.** Until the DEN PM's final written acceptance of the entire completed work, excepting only those portions of the work accepted in accordance with Section 50, paragraph 50-14, *Partial Acceptance*, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part due to the action of

the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of government authorities.

If the work is suspended for any cause whatever, the Contractor shall be responsible for the work and shall take such precautions necessary to prevent damage to the work. The Contractor shall provide for normal drainage and shall erect necessary temporary structures, signs, or other facilities at their own expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established planting, seeding, and sodding furnished under the contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

**70-15 Contractor’s responsibility for utility service and facilities of others.** As provided in paragraph 70-04, *Restoration of Surfaces Disturbed by Others*, the Contractor shall cooperate with the owner of any public or private utility service, FAA or NOAA, or a utility service of another government agency that may be authorized by the Owner to construct, reconstruct or maintain such utility services or facilities during the progress of the work. In addition, the Contractor shall control their operations to prevent the unscheduled interruption of such utility services and facilities.

To the extent that such public or private utility services, FAA, or NOAA facilities, or utility services of another governmental agency are known to exist within the limits of the contract work, the approximate locations have been indicated on the plans and/or in the contract documents.

It is understood and agreed that the Owner does not guarantee the accuracy or the completeness of the location information relating to existing utility services, facilities, or structures that may be shown on the plans or encountered in the work. Any inaccuracy or omission in such information shall not relieve the Contractor of the responsibility to protect such existing features from damage or unscheduled interruption of service.

It is further understood and agreed that the Contractor shall, upon execution of the contract, notify the Owners of all utility services or other facilities of their plan of operations. Such notification shall be in writing addressed to “The Person to Contact” as provided in this paragraph and paragraph 70-04, *Restoration of Surfaces Disturbed By Others*. A copy of each notification shall be given to the DEN PM.

In addition to the general written notification provided, it shall be the responsibility of the Contractor to keep such individual Owners advised of changes in their plan of operations that would affect such Owners.

Prior to beginning the work in the general vicinity of an existing utility service or facility, the Contractor shall again notify each such Owner of their plan of operation. If, in the Contractor’s opinion, the Owner’s assistance is needed to locate the utility service or facility or the presence of a representative of the Owner is desirable to observe the work, such advice should be included in the notification. Such notification shall be given by the most expeditious means to reach the utility owner’s “Person to Contact” no later than two normal business days prior to the

Contractor's commencement of operations in such general vicinity. The Contractor shall furnish a written summary of the notification to the DEN PM.

The Contractor's failure to give the two days' notice shall be cause for the Owner to suspend the Contractor's operations in the general vicinity of a utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the Contractor shall be required to use hand excavation methods within 3 feet (1 m) of such outside limits at such points as may be required to ensure protection from damage due to the Contractor's operations.

Should the Contractor damage or interrupt the operation of a utility service or facility by accident or otherwise, the Contractor shall immediately notify the proper authority and the DEN PM and shall take all reasonable measures to prevent further damage or interruption of service. The Contractor, in such events, shall cooperate with the utility service or facility owner and the DEN PM continuously until such damage has been repaired and service restored to the satisfaction of the utility or facility owner.

The Contractor shall bear all costs of damage and restoration of service to any utility service or facility due to their operations whether due to negligence or accident. The Owner reserves the right to deduct such costs from any monies due or which may become due the Contractor, or their own surety.

**70-15.1 FAA facilities and cable runs.** The Contractor is hereby advised that the construction limits of the project include existing facilities and buried cable runs that are owned, operated and maintained by the FAA. The Contractor, during the execution of the project work, shall comply with the following:

**a.** The Contractor shall permit FAA maintenance personnel the right of access to the project work site for purposes of inspecting and maintaining all existing FAA owned facilities.

**b.** The Contractor shall provide notice to the FAA Air Traffic Organization (ATO)/Technical Operations/System Support Center (SSC) Point-of-Contact through the airport DEN PM a minimum of seven (7) calendar days prior to commencement of construction activities in order to permit sufficient time to locate and mark existing buried cables and to schedule any required facility outages.

**c.** If execution of the project work requires a facility outage, the Contractor shall contact the FAA Point-of-Contact a minimum of 72 hours prior to the time of the required outage.

**d.** Any damage to FAA cables, access roads, or FAA facilities during construction caused by the Contractor's equipment or personnel whether by negligence or accident will require the Contractor to repair or replace the damaged cables, access road, or FAA facilities to FAA requirements. The Contractor shall not bear the cost to repair damage to underground facilities or utilities improperly located by the FAA.

**e.** If the project work requires the cutting or splicing of FAA owned cables, the FAA Point-of-Contact shall be contacted a minimum of 72 hours prior to the time the cable work commences. The FAA reserves the right to have a FAA representative on site to observe the splicing of the cables as a condition of acceptance. All cable splices are to be accomplished in accordance with FAA specifications and require approval by the FAA Point-of-Contact as a condition of acceptance by the Owner. The Contractor is hereby advised that FAA restricts the location of where splices may be installed. If a cable splice is required in a location that is not permitted by FAA, the Contractor shall furnish and install a sufficient length of new cable that eliminates the need for any splice.

**70-16 Furnishing rights-of-way.** The Owner will be responsible for furnishing all rights-of-way upon which the work is to be constructed in advance of the Contractor's operations.

**70-17 Personal liability of public officials.** In carrying out any of the contract provisions or in exercising any power or authority granted by this contract, there shall be no liability upon the Engineer, DEN PM, their authorized representatives, or any officials of the Owner either personally or as an official of the Owner. It is understood that in such matters they act solely as agents and representatives of the Owner.

**70-18 No waiver of legal rights.** Upon completion of the work, the Owner will expeditiously make final inspection and notify the Contractor of final acceptance. Such final acceptance, however, shall not preclude or stop the Owner from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Owner be precluded or stopped from recovering from the Contractor or their surety, or both, such overpayment as may be sustained, or by failure on the part of the Contractor to fulfill their obligations under the contract. A waiver on the part of the Owner of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Owner for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Owner's rights under any warranty or guaranty.

**70-19 Environmental protection.** The Contractor shall comply with all federal, state, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuels, oils, asphalts, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

**70-20 Archaeological and historical findings.** Unless otherwise specified in this subsection, the Contractor is advised that the site of the work is not within any property, district, or site, and does not contain any building, structure, or object listed in the current National Register of Historic Places published by the United States Department of Interior.

Should the Contractor encounter, during their operations, any building, part of a building, structure, or object that is incongruous with its surroundings, the Contractor shall immediately cease operations in that location and notify the DEN PM. The DEN PM will immediately investigate the Contractor's finding and the Owner will direct the Contractor to either resume operations or to suspend operations as directed.

Should the Owner order suspension of the Contractor's operations in order to protect an archaeological or historical finding, or order the Contractor to perform extra work, such shall be covered by an appropriate contract change order or supplemental agreement as provided in Section 40, paragraph 40-04, *Extra Work*, and Section 90, paragraph 90-05, *Payment for Extra Work*. If appropriate, the contract change order or supplemental agreement shall include an extension of contract time in accordance with Section 80, paragraph 80-07, *Determination and Extension of Contract Time*.

## END OF SECTION 70

## Section 80 Execution and Progress

**80-01 Subletting of contract.** The Owner will not recognize any subcontractor on the work. The Contractor shall at all times when work is in progress be represented either in person, by a qualified superintendent, or by other designated, qualified representative who is duly authorized to receive and execute orders of the DEN Project Manager (DEN PM).

The Contractor shall perform, with his organization, an amount of work equal to at least 40 percent of the total contract cost.

Should the Contractor elect to assign their contract, said assignment shall be concurred in by the surety, shall be presented for the consideration and approval of the Owner, and shall be consummated only on the written approval of the Owner.

The Contractor shall provide copies of all subcontracts to the DEN PM 14 days prior to being utilized on the project. As a minimum, the information shall include the following:

- Subcontractor's legal company name.
- Subcontractor's legal company address, including County name.
- Principal contact person's name, telephone and fax number.
- Complete narrative description, and dollar value of the work to be performed by the subcontractor.
- Copies of required insurance certificates in accordance with the specifications.
- Minority/ non-minority status.

**80-02 Notice to proceed (NTP).** The Owners notice to proceed will state the date on which contract time commences. The Contractor is expected to commence project operations within 10 days of the NTP date. The Contractor shall notify the DEN PM at least 24 hours in advance of the time contract operations begins. The Contractor shall not commence any actual operations prior to the date on which the notice to proceed is issued by the Owner.

**80-03 Execution and progress.** Unless otherwise specified, the Contractor shall submit their coordinated construction schedule showing all work activities for the DEN PM's review and acceptance at least 10 days prior to the start of work. The Contractor's progress schedule, once accepted by the DEN PM, will represent the Contractor's baseline plan to accomplish the project in accordance with the terms and conditions of the Contract. The DEN PM will compare actual Contractor progress against the baseline schedule to determine that status of the Contractor's performance. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the proposal.

If the Contractor falls significantly behind the submitted schedule, the Contractor shall, upon the DEN PM's request, submit a revised schedule for completion of the work within the contract time and modify their operations to provide such additional materials, equipment, and labor necessary to meet the revised schedule. Should the execution of the work be discontinued for

any reason, the Contractor shall notify the DEN PM at least 24 hours in advance of resuming operations.

The Contractor shall not commence any actual construction prior to the date on which the NTP is issued by the Owner.

The project schedule shall be prepared as a network diagram in Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), or other format, or as otherwise specified. It shall include information on the sequence of work activities, milestone dates, and activity duration. The schedule shall show all work items identified in the project proposal for each work area and shall include the project start date and end date.

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

**80-04 Limitation of operations.** The Contractor shall control their operations and the operations of their subcontractors and all suppliers to provide for the free and unobstructed movement of aircraft in the air operations areas (AOA) of the airport.

When the work requires the Contractor to conduct their operations within an AOA of the airport, the work shall be coordinated with airport operations (through the DEN PM) at least 48 hours prior to commencement of such work. The Contractor shall not close an AOA until so authorized by the DEN PM and until the necessary temporary marking, signage and associated lighting is in place as provided in Section 70, paragraph 70-08, *Construction Safety and Phasing Plan (CSPP)*.

When the contract work requires the Contractor to work within an AOA of the airport on an intermittent basis (intermittent opening and closing of the AOA), the Contractor shall maintain constant communications as specified; immediately obey all instructions to vacate the AOA; and immediately obey all instructions to resume work in such AOA. Failure to maintain the specified communications or to obey instructions shall be cause for suspension of the Contractor's operations in the AOA until satisfactory conditions are provided. The areas of the AOA identified in the Construction Safety Phasing Plan (CSPP) and as listed below, cannot be closed to operating aircraft to permit the Contractor's operations on a continuous basis and will therefore be closed to aircraft operations intermittently as follows:

Refer to the Milestone Sheets of the Construction Drawings.

The Contractor shall be required to conform to safety standards contained in AC 150/5370-2, Operational Safety on Airports During Construction and the approved CSPP.

**80-04.1 Operational safety on airport during construction.** All Contractors' operations shall be conducted in accordance with the approved project Construction Safety and Phasing Plan (CSPP) and the Safety Plan Compliance Document (SPCD) and the provisions set forth within the current version of AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP included within the contract documents conveys minimum requirements for operational safety on the airport during construction activities. The Contractor shall prepare and submit a SPCD that details how it proposes to comply with the requirements presented within the CSPP.

The Contractor shall implement all necessary safety plan measures prior to commencement of any work activity. The Contractor shall conduct routine checks to assure compliance with the safety plan measures.

The Contractor is responsible to the Owner for the conduct of all subcontractors it employs on the project. The Contractor shall assure that all subcontractors are made aware of the requirements of the CSPP and SPCD and that they implement and maintain all necessary measures.

No deviation or modifications may be made to the approved CSPP and SPCD unless approved in writing by the Owner. The necessary coordination actions to review Contractor proposed modifications to an approved CSPP or approved SPCD can require a significant amount of time.

**80-05 Character of workers, methods, and equipment.** The Contractor shall, at all times, employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by the contract, plans, and specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the Contractor or by any subcontractor who violates any operational regulations or operational safety requirements and, in the opinion of the DEN PM, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the DEN PM, be removed immediately by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without approval of the DEN PM.

Should the Contractor fail to remove such person or persons, or fail to furnish suitable and sufficient personnel for the proper execution of the work, the DEN PM may suspend the work by written notice until compliance with such orders.

All equipment that is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the work shall not cause injury to previously completed work, adjacent property, or existing airport facilities due to its use.

When the methods and equipment to be used by the Contractor in accomplishing the work are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the work in conformity with the requirements of the contract, plans, and specifications.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless otherwise authorized by the DEN PM. If the Contractor desires to use a method or type of equipment other than specified in the contract, the Contractor may request authority from the DEN PM to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the DEN PM determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove any deficient work and replace it with work of specified quality, or take such other corrective action as the DEN PM may direct. No change will be made in basis of payment for the contract items involved nor in contract time as a result of authorizing a change in methods or equipment under this paragraph.

**80-06 Temporary suspension of the work.** The Owner shall have the authority to suspend the work wholly, or in part, for such period or periods the Owner may deem necessary, due to

unsuitable weather, or other conditions considered unfavorable for the execution of the work, or for such time necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract.

In the event that the Contractor is ordered by the Owner, in writing, to suspend work for some unforeseen cause not otherwise provided for in the contract and over which the Contractor has no control, the Contractor may be reimbursed for actual money expended on the work during the period of shutdown. No allowance will be made for anticipated profits. The period of shutdown shall be computed from the effective date of the written order to suspend work to the effective date of the written order to resume the work. Claims for such compensation shall be filed with the DEN PM within the time period stated in the DEN PM's order to resume work. The Contractor shall submit with their own claim information substantiating the amount shown on the claim. The DEN PM will forward the Contractor's claim to the Owner for consideration in accordance with local laws or ordinances. No provision of this article shall be construed as entitling the Contractor to compensation for delays due to inclement weather or for any other delay provided for in the contract, plans, or specifications.

If it becomes necessary to suspend work for an indefinite period, the Contractor shall store all materials in such manner that they will not become an obstruction nor become damaged in any way. The Contractor shall take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The Contractor shall erect temporary structures where necessary to provide for traffic on, to, or from the airport.

**80-07 Determination and extension of contract time.** The number of calendar days shall be stated in the proposal and contract and shall be known as the Contract Time.

If the contract time requires extension for reasons beyond the Contractor's control, it shall be adjusted as follows:

**80-07.1 Contract time based on calendar days.** Contract Time based on calendar days shall consist of the number of calendar days stated in the contract counting from the effective date of the Notice to Proceed and including all Saturdays, Sundays, holidays, and non-work days. All calendar days elapsing between the effective dates of the Owner's orders to suspend and resume all work, due to causes not the fault of the Contractor, shall be excluded.

At the time of final payment, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in the contract time shall not consider either cost of work or the extension of contract time that has been covered by a change order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.

**80-08 Failure to complete on time.** For each calendar day or working day, as specified in the contract, that any work remains uncompleted after the contract time (including all extensions and adjustments as provided in paragraph 80-07, *Determination and Extension of Contract Time*) the sum specified in the contract and proposal as liquidated damages (LD) will be deducted from any money due or to become due the Contractor or their own surety. Such deducted sums shall not be deducted as a penalty but shall be considered as liquidation of a reasonable portion of damages including but not limited to additional engineering services that will be incurred by the Owner should the Contractor fail to complete the work in the time provided in their contract.

Schedule	Liquidated Damages Cost	Allowed Construction Time
All	\$7,500/ Day	411 Calendar Days

The maximum construction time allowed for All Schedules combined will be 411 calendar days. Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Owner of any of its rights under the contract.

**The contract time is an essential part of each contract for construction on airports and should be considered carefully in the preparation of plans and specifications.**

**80-09 Default and termination of contract.** The Contractor shall be considered in default of their contract and such default will be considered as cause for the Owner to terminate the contract for any of the following reasons, if the Contractor:

- a. Fails to begin the work under the contract within the time specified in the Notice to Proceed, or
- b. Fails to perform the work or fails to provide sufficient workers, equipment and/or materials to assure completion of work in accordance with the terms of the contract, or
- c. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
- d. Discontinues the execution of the work, or
- e. Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
- f. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
- g. Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 days, or
- h. Makes an assignment for the benefit of creditors, or
- i. For any other cause whatsoever, fails to carry on the work in an acceptable manner.

Should the Owner consider the Contractor in default of the contract for any reason above, the Owner shall immediately give written notice to the Contractor and the Contractor's surety as to the reasons for considering the Contractor in default and the Owner's intentions to terminate the contract.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Owner will, upon written notification from the DEN PM of the facts of such delay, neglect, or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the execution of the work out of the hands of the Contractor. The Owner may appropriate or use any or all materials and equipment that have been mobilized for use in the work and are acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the DEN PM will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Owner, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due the Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the Owner the amount of such excess.

**80-10 Termination for national emergencies.** The Owner shall terminate the contract or portion thereof by written notice when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the execution of war or in the interest of national defense.

When the contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract price or as mutually agreed for items of work partially completed or not started. No claims or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the DEN PM.

Termination of the contract or a portion thereof shall neither relieve the Contractor of their responsibilities for the completed work nor shall it relieve their surety of its obligation for and concerning any just claim arising out of the work performed.

**80-11 Work area, storage area and sequence of operations.** The Contractor shall obtain approval from the DEN PM prior to beginning any work in all areas of the airport. No operating runway, taxiway, or air operations area (AOA) shall be crossed, entered, or obstructed while it is operational. The Contractor shall plan and coordinate work in accordance with the approved CSPP and SPCD.

**END OF SECTION**

## Section 90 Measurement and Payment

**90-01 Measurement of quantities.** All work completed under the contract will be measured by the RPR, or their authorized representatives, using United States Customary Units of Measurement.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (or leave-outs) having an area of 9 square feet (0.8 square meters) or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the RPR.

Unless otherwise specified, all contract items which are measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains, and similar items shall be measured parallel to the base or foundation upon which such items are placed.

The term “lump sum” when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure or structural unit (in effect, “lump sum” work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When requested by the Contractor and approved by the RPR in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed, and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the RPR and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

### Measurement and Payment Terms

Term	Description
<b>Excavation and Embankment Volume</b>	In computing volumes of excavation, the average end area method will be used unless otherwise specified.
<b>Measurement and Proportion by Weight</b>	The term “ton” will mean the short ton consisting of 2,000 pounds (907 kg) avoirdupois. All materials that are measured or proportioned by weights shall be weighed on accurate, independently certified scales by competent, qualified personnel at locations designated by the RPR. If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty.

TECHNICAL SPECIFICATIONS  
 DIVISION 2 – AIRFIELD STANDARDS  
 SECTION 90 MEASUREMENT AND PAYMENT

DENVER INTERNATIONAL AIRPORT  
 TAXIWAY DS EAST  
 CONTRACT NO. 201737642-02

Term	Description
	daily at such times as the RPR directs, and each truck shall bear a plainly legible identification mark.
<b>Measurement by Volume</b>	Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable for the materials hauled, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery.
<b>Asphalt Material</b>	Asphalt materials will be measured by the gallon (liter) or ton (kg). When measured by volume, such volumes will be measured at 60°F (16°C) or will be corrected to the volume at 60°F (16°C) using ASTM D1250 for asphalts. Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when asphalt material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work. When asphalt materials are shipped by truck or transport, net certified weights by volume, subject to correction for loss or foaming, will be used for computing quantities.
<b>Cement</b>	Cement will be measured by the ton (kg) or hundredweight (km).
<b>Structure</b>	Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.
<b>Timber</b>	Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.
<b>Plates and Sheets</b>	The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fraction of inch.
<b>Miscellaneous Items</b>	When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.
<b>Scales</b>	Scales must be tested for accuracy and serviced before use. Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected, and maintained by the Contractor, or be certified permanently installed commercial scales. Platform scales shall be installed and maintained with the platform level and rigid bulkheads at each end.

TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 90 MEASUREMENT AND PAYMENT

DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02

Term	Description
	<p>Scales shall be accurate within 0.5% of the correct weight throughout the range of use. The Contractor shall have the scales checked under the observation of the RPR before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam or dial and shall not exceed 0.1% of the nominal rated capacity of the scale, but not less than one pound (454 grams). The use of spring balances will not be permitted.</p> <p>In the event inspection reveals the scales have been “overweighing” (indicating more than correct weight) they will be immediately adjusted. All materials received subsequent to the last previous correct weighting-accuracy test will be reduced by the percentage of error in excess of 0.5%.</p> <p>In the event inspection reveals the scales have been under-weighing (indicating less than correct weight), they shall be immediately adjusted. No additional payment to the Contractor will be allowed for materials previously weighed and recorded.</p> <p>Beams, dials, platforms, and other scale equipment shall be so arranged that the operator and the RPR can safely and conveniently view them.</p> <p>Scale installations shall have available ten standard 50-pound (2.3 km) weights for testing the weighing equipment or suitable weights and devices for other approved equipment.</p> <p>All costs in connection with furnishing, installing, certifying, testing, and maintaining scales; for furnishing check weights and scale house; and for all other items specified in this subsection, for the weighing of materials for proportioning or payment, shall be included in the unit contract prices for the various items of the project.</p>
<b>Rental Equipment</b>	<p>Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Special equipment ordered in connection with extra work will be measured as agreed in the change order or supplemental agreement authorizing such work as provided in paragraph 90-05 <i>Payment for Extra Work</i>.</p>
<b>Pay Quantities</b>	<p>When the estimated quantities for a specific portion of the work are designated as the pay quantities in the contract, they shall be the final quantities for which payment for such specific portion of the work will be made, unless the dimensions of said portions of the work shown on the plans are revised by the RPR. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment will be revised in the amount represented by the authorized changes in the dimensions.</p>

**90-02 Scope of payment.** The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials, for performing all work under the contract in a complete and acceptable manner, and for all risk, loss, damage, or expense of

whatever character arising out of the nature of the work or the execution thereof, subject to the provisions of Section 70, paragraph 70-18, *No Waiver of Legal Rights*.

When the “basis of payment” subsection of a technical specification requires that the contract price (price bid) include compensation for certain work or material essential to the item, this same work or material will not also be measured for payment under any other contract item which may appear elsewhere in the contract, plans, or specifications.

**90-03 Compensation for altered quantities.** When the accepted quantities of work vary from the quantities in the proposal, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract price for the accepted quantities of work actually completed and accepted. No allowance, except as provided for in Section 40, paragraph 40-02, *Alteration of Work and Quantities*, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor which results directly from such alterations or indirectly from their own unbalanced allocation of overhead and profit among the contract items, or from any other cause.

**90-04 Payment for omitted items.** As specified in Section 40, paragraph 40-03, *Omitted Items*, the RPR shall have the right to omit from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Owner.

Should the RPR omit or order nonperformance of a contract item or portion of such item from the work, the Contractor shall accept payment in full at the contract prices for any work actually completed and acceptable prior to the RPR’s order to omit or non-perform such contract item.

Acceptable materials ordered by the Contractor or delivered on the work prior to the date of the RPR’s order will be paid for at the actual cost to the Contractor and shall thereupon become the property of the Owner.

In addition to the reimbursement hereinbefore provided, the Contractor shall be reimbursed for all actual costs incurred for the purpose of performing the omitted contract item prior to the date of the RPR’s order. Such additional costs incurred by the Contractor must be directly related to the deleted contract item and shall be supported by certified statements by the Contractor as to the nature the amount of such costs.

**90-05 Payment for extra work.** Extra work, performed in accordance with Section 40, paragraph 40-04, *Extra Work*, will be paid for at the contract prices or agreed prices specified in the change order or supplemental agreement authorizing the extra work.

**90-06 Partial payments.** Partial payments will be made to the Contractor at least once each month as the work progresses. Said payments will be based upon estimates, prepared by the RPR, of the value of the work performed and materials complete and in place, in accordance with the contract, plans, and specifications. Such partial payments may also include the delivered actual cost of those materials stockpiled and stored in accordance with paragraph 90-07, *Payment for Materials on Hand*. No partial payment will be made when the amount due to the Contractor since the last estimate amounts to less than five hundred dollars.

It is understood and agreed that the Contractor shall not be entitled to demand or receive partial payment based on quantities of work in excess of those provided in the proposal or covered by approved change orders or supplemental agreements, except when such excess quantities have been determined by the RPR to be a part of the final quantity for the item of work in question.

No partial payment shall bind the Owner to the acceptance of any materials or work in place as to quality or quantity. All partial payments are subject to correction at the time of final payment as provided in paragraph 90-09, *Acceptance and Final Payment*.

The Contractor shall deliver to the Owner a complete release of all claims for labor and material arising out of this contract before the final payment is made. If any subcontractor or supplier fails to furnish such a release in full, the Contractor may furnish a bond or other collateral satisfactory to the Owner to indemnify the Owner against any potential lien or other such claim. The bond or collateral shall include all costs, expenses, and attorney fees the Owner may be compelled to pay in discharging any such lien or claim.

**90-07 Payment for materials on hand.** Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the contract, plans, and specifications and are delivered to acceptable sites on the airport property or at other sites in the vicinity that are acceptable to the Owner. Such delivered costs of stored or stockpiled materials may be included in the next partial payment after the following conditions are met:

a. The material has been stored or stockpiled in a manner acceptable to the RPR at or on an approved site.

b. The Contractor has furnished the RPR with acceptable evidence of the quantity and quality of such stored or stockpiled materials.

c. The Contractor has furnished the RPR with satisfactory evidence that the material and transportation costs have been paid.

d. The Contractor has furnished the Owner legal title (free of liens or encumbrances of any kind) to the material stored or stockpiled.

e. The Contractor has furnished the Owner evidence that the material stored or stockpiled is insured against loss by damage to or disappearance of such materials at any time prior to use in the work.

It is understood and agreed that the transfer of title and the Owner's payment for such stored or stockpiled materials shall in no way relieve the Contractor of their responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans, and specifications.

In no case will the amount of partial payments for materials on hand exceed the contract price for such materials or the contract price for the contract item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the partial payment of stored or stockpiled materials in accordance with the provisions of this paragraph.

**90-08 Payment of withheld funds.** At the Contractor's option, if an Owner withholds retainage in accordance with the methods described in paragraph 90-06 *Partial Payments*, the Contractor may request that the Owner deposit the retainage into an escrow account. The Owner's deposit of retainage into an escrow account is subject to the following conditions:

a. The Contractor shall bear all expenses of establishing and maintaining an escrow account and escrow agreement acceptable to the Owner.

**b.** The Contractor shall deposit to and maintain in such escrow only those securities or bank certificates of deposit as are acceptable to the Owner and having a value not less than the retainage that would otherwise be withheld from partial payment.

**c.** The Contractor shall enter into an escrow agreement satisfactory to the Owner.

**d.** The Contractor shall obtain the written consent of the surety to such agreement.

**90-09 Acceptance and final payment.** When the contract work has been accepted in accordance with the requirements of Section 50, paragraph 50-15, *Final Acceptance*, the RPR will prepare the final estimate of the items of work actually performed. The Contractor shall approve the RPR's final estimate or advise the RPR of the Contractor's objections to the final estimate which are based on disputes in measurements or computations of the final quantities to be paid under the contract as amended by change order or supplemental agreement. The Contractor and the RPR shall resolve all disputes (if any) in the measurement and computation of final quantities to be paid within 30 calendar days of the Contractor's receipt of the RPR's final estimate. If, after such 30-day period, a dispute still exists, the Contractor may approve the RPR's estimate under protest of the quantities in dispute, and such disputed quantities shall be considered by the Owner as a claim in accordance with Section 50, paragraph 50-16, *Claims for Adjustment and Disputes*.

After the Contractor has approved, or approved under protest, the RPR's final estimate, and after the RPR's receipt of the project closeout documentation required in paragraph 90-11, *Contractor Final Project Documentation*, final payment will be processed based on the entire sum, or the undisputed sum in case of approval under protest, determined to be due the Contractor less all previous payments and all amounts to be deducted under the provisions of the contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

If the Contractor has filed a claim for additional compensation under the provisions of Section 50, paragraph 50-16, *Claims for Adjustments and Disputes*, or under the provisions of this paragraph, such claims will be considered by the Owner in accordance with local laws or ordinances. Upon final adjudication of such claims, any additional payment determined to be due the Contractor will be paid pursuant to a supplemental final estimate.

**90-10 Construction warranty.**

**a.** In addition to any other warranties in this contract, the Contractor warrants that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, workmanship, or design furnished, or performed by the Contractor or any subcontractor or supplier at any tier.

**b.** This warranty shall continue for a period of one year from the date of final acceptance of the work, except as noted. If the Owner takes possession of any part of the work before final acceptance, this warranty shall continue for a period of one year from the date the Owner takes possession. However, this will not relieve the Contractor from corrective items required by the final acceptance of the project work. Light Emitting Diode emitting diode (LED) light fixtures with the exception of obstruction lighting, must be warranted by the manufacturer for a minimum of four (4) years after date of installation inclusive of all electronics.

**c.** The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Owner real or personal property, when that damage is the result of the Contractor's failure to conform to contract requirements; or any defect of equipment, material, workmanship, or design furnished by the Contractor.

**d.** The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for one year from the date of repair or replacement.

**e.** The Owner will notify the Contractor, in writing, within seven (7) days after the discovery of any failure, defect, or damage.

**f.** If the Contractor fails to remedy any failure, defect, or damage within 14 days after receipt of notice, the Owner shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

**g.** With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall: (1) Obtain all warranties that would be given in normal commercial practice; (2) Require all warranties to be executed, in writing, for the benefit of the Owner, as directed by the Owner, and (3) Enforce all warranties for the benefit of the Owner.

**h.** This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.

**90-11 Contractor Final Project Documentation.** Approval of final payment to the Contractor is contingent upon completion and submittal of the items listed below. The final payment will not be approved until the RPR approves the Contractor's final submittal. The Contractor shall:

**a.** Provide two (2) copies of all manufacturers warranties specified for materials, equipment, and installations.

**b.** Provide weekly payroll records (not previously received) from the general Contractor and all subcontractors.

**c.** Complete final cleanup in accordance with Section 40, paragraph 40-08, *Final Cleanup*.

**d.** Complete all punch list items identified during the Final Inspection.

**e.** Provide complete release of all claims for labor and material arising out of the Contract.

**f.** Provide a certified statement signed by the subcontractors, indicating actual amounts paid to the Disadvantaged Business Enterprise (DBE) subcontractors and/or suppliers associated with the project.

**g.** When applicable per state requirements, return copies of sales tax completion forms.

**h.** Manufacturer's certifications for all items incorporated in the work.

**i.** All required record drawings, as-built drawings or as-constructed drawings.

**j.** Project Operation and Maintenance (O&M) Manual(s).

**k.** Security for Construction Warranty.

**l.** Equipment commissioning documentation submitted, if required.

## **END OF SECTION 90**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 90 MEASUREMENT AND PAYMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
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### **Item C-100 Contractor Quality Control Program (CQCP)**

**100-1 General.** Quality is more than test results. Quality is the combination of proper materials, testing, workmanship, equipment, inspection, and documentation of the project. Establishing and maintaining a culture of quality is key to achieving a quality project. The Contractor shall establish, provide, and maintain an effective Contractor Quality Control Program (CQCP) that details the methods and procedures that will be taken to assure that all materials and completed construction required by this contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified here and elsewhere in the contract technical specifications, the Contractor shall assume full responsibility for accomplishing the stated purpose.

The Contractor shall establish a CQCP that will:

- a. Provide qualified personnel to develop and implement the CQCP.
- b. Provide for the production of acceptable quality materials.
- c. Provide sufficient information to assure that the specification requirements can be met.
- d. Document the CQCP process.

The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the CQCP has been reviewed and approved by the DEN Project Manager (DEN PM). No partial payment will be made for materials subject to specific quality control (QC) requirements until the CQCP has been reviewed and approved.

The QC requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the quality assurance (QA) testing requirements. QA testing requirements are the responsibility of the DEN PM or Contractor as specified in the specifications.

A Quality Control (QC)/Quality Assurance (QA) workshop with the Engineer, DEN PM, Contractor, subcontractors, testing laboratories, and Owner's representative must be held prior to start of construction. The QC/QA workshop will be facilitated by the Contractor. The Contractor shall coordinate with the Airport and the DEN PM on time and location of the QC/QA workshop. Items to be addressed, at a minimum, will include:

- a. Review of the CQCP including submittals, QC Testing, Action & Suspension Limits for Production, Corrective Action Plans, Distribution of QC reports, and Control Charts.
- b. Discussion of the QA program.
- c. Discussion of the QC and QA Organization and authority including coordination and information exchange between QC and QA.
- d. Establish regular meetings to discuss control of materials, methods and testing.
- e. Establishment of the overall QC culture.

**100-2 Description of program.**

**a. General description.** The Contractor shall establish a CQCP to perform QC inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors. The CQCP shall ensure conformance to applicable specifications and plans with respect to materials, off-site fabrication, workmanship, construction, finish, and functional performance. The CQCP shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of QC.

**b. Contractor Quality Control Program (CQCP).** The Contractor shall describe the CQCP in a written document that shall be reviewed and approved by the DEN PM prior to the start of any production, construction, or off-site fabrication. The written CQCP shall be submitted to the DEN PM for review and approval at least 10 calendar days before the CQCP Workshop. The Contractor's CQCP and QC testing laboratory must be approved in writing by the DEN PM prior to the Notice to Proceed (NTP).

The CQCP shall be organized to address, as a minimum, the following:

1. QC organization and resumes of key staff
2. Project progress schedule
3. Submittals schedule
4. Inspection requirements
5. QC testing plan
6. Documentation of QC activities and distribution of QC reports
7. Requirements for corrective action when QC and/or QA acceptance criteria are not met
8. Material quality and construction means and methods. Address all elements applicable to the project that affect the quality of the pavement structure including subgrade, subbase, base, and surface course. Some elements that must be addressed include, but is not limited to mix design, aggregate grading, stockpile management, mixing and transporting, placing and finishing, quality control testing and inspection, smoothness, laydown plan, equipment, and temperature management plan.

The Contractor must add any additional elements to the CQCP that is necessary to adequately control all production and/or construction processes required by this contract.

**100-3 CQCP organization.** The CQCP shall be implemented by the establishment of a QC organization. An organizational chart shall be developed to show all QC personnel, their authority, and how these personnel integrate with other management/production and construction functions and personnel.

The organizational chart shall identify all QC staff by name and function, and shall indicate the total staff required to implement all elements of the CQCP, including inspection and testing for each item of work. If necessary, different technicians can be used for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the CQCP, the personnel assigned shall be subject to the qualification requirements of paragraphs 100-03a and 100-03b. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

The QC organization shall, as a minimum, consist of the following personnel:

**a. Program Administrator.** The Contractor Quality Control Program Administrator (CQCPA) must be a full-time employee of the Contractor, or a consultant engaged by the Contractor. The CQCPA must have a minimum of five (5) years of experience in QC pavement construction with prior QC experience on a project of comparable size and scope as the contract.

Included in the five (5) years of paving/QC experience, the CQCPA must meet at least one of the following requirements:

- (1) Professional Engineer with one (1) year of airport paving experience.
- (2) Engineer-in-training with two (2) years of airport paving experience.
- (3) National Institute for Certification in Engineering Technologies (NICET) Civil Engineering Technology Level IV with three (3) years of airport paving experience.
- (4) An individual with four (4) years of airport paving experience, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

The CQCPA must have full authority to institute any and all actions necessary for the successful implementation of the CQCP to ensure compliance with the contract plans and technical specifications. The CQCPA authority must include the ability to immediately stop production until materials and/or processes are in compliance with contract specifications. The CQCPA must report directly to a principal officer of the construction firm. The CQCPA may supervise the Quality Control Program on more than one project provided that person can be at the job site within two (2) hours after being notified of a problem.

**b. QC technicians.** A sufficient number of QC technicians necessary to adequately implement the CQCP must be provided. These personnel must be either Engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field equivalent to NICET Level II in Civil Engineering Technology or higher, and shall have a minimum of two (2) years of experience in their area of expertise.

The QC technicians must report directly to the CQCPA and shall perform the following functions:

- (1) Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by paragraph 100-6.
- (2) Performance of all QC tests as required by the technical specifications and paragraph 100-8.
- (3) Performance of tests for the DEN PM when required by the technical specifications.

Certification at an equivalent level of qualification and experience by a state or nationally recognized organization will be acceptable in lieu of NICET certification.

**c. Staffing levels.** The Contractor shall provide sufficient qualified QC personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The CQCP shall state where different technicians will be required for different work elements.

**100-4 Project progress schedule.** Critical QC activities must be shown on the project schedule as required by Section 80, paragraph 80-03, *Execution and Progress*.

**100-5 Submittals schedule.** The Contractor shall submit a detailed listing of all submittals (for example, mix designs, material certifications) and shop drawings required by the technical specifications. The listing can be developed in a spreadsheet format and shall include as a minimum:

- a. Specification item number
- b. Item description
- c. Description of submittal
- d. Specification paragraph requiring submittal
- e. Scheduled date of submittal

**100-6 Inspection requirements.** QC inspection functions shall be organized to provide inspections for all definable features of work, as detailed below. All inspections shall be documented by the Contractor as specified by paragraph 100-9.

Inspections shall be performed as needed to ensure continuing compliance with contract requirements until completion of the particular feature of work. Inspections shall include the following minimum requirements:

a. During plant operation for material production, QC test results and periodic inspections shall be used to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment used in proportioning and mixing shall be inspected to ensure its proper operating condition. The CQCP shall detail how these and other QC functions will be accomplished and used.

b. During field operations, QC test results and periodic inspections shall be used to ensure the quality of all materials and workmanship. All equipment used in placing, finishing, and compacting shall be inspected to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The CQCP shall document how these and other QC functions will be accomplished and used.

**100-7 Contractor QC testing facility.**

a. For projects that include Item P-401, Item P-403, and Item P-404, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM D3666, *Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials*:

- 8.1.3 Equipment Calibration and Checks;
- 8.1.9 Equipment Calibration, Standardization, and Check Records;
- 8.1.12 Test Methods and Procedures

b. For projects that include P-501, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM C1077, *Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation*:

- 7 Test Methods and Procedures
- 8 Facilities, Equipment, and Supplemental Procedures

**100-8 QC testing plan.** As a part of the overall CQCP, the Contractor shall implement a QC testing plan, as required by the technical specifications. The testing plan shall include the minimum tests and test frequencies required by each technical specification Item, as well as any additional QC tests that the Contractor deems necessary to adequately control production and/or construction processes.

The QC testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:

- a. Specification item number (e.g., P-401)
- b. Item description (e.g., Hot Mix Asphalt Pavements)
- c. Test type (e.g., gradation, grade, asphalt content)
- d. Test standard (e.g., ASTM or American Association of State Highway and Transportation Officials (AASHTO) test number, as applicable)
- e. Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated)
- f. Responsibility (e.g., plant technician)
- g. Control requirements (e.g., target, permissible deviations)

The QC testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D3665. The DEN PM shall be provided the opportunity to witness QC sampling and testing.

All QC test results shall be documented by the Contractor as required by paragraph 100-9.

**100-9 Documentation.** The Contractor shall maintain current QC records of all inspections and tests performed. These records shall include factual evidence that the required QC inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.

These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the terms of the contract. Legible copies of these records shall be furnished to the DEN PM daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the CQCPA.

Contractor QC records required for the contract shall include, but are not necessarily limited to, the following records:

**a. Daily inspection reports.** Each Contractor QC technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations. These technician's daily reports shall provide factual evidence that continuous QC inspections have been performed and shall, as a minimum, include the following:

- (1) Technical specification item number and description
- (2) Compliance with approved submittals
- (3) Proper storage of materials and equipment
- (4) Proper operation of all equipment
- (5) Adherence to plans and technical specifications
- (6) Summary of any necessary corrective actions

- (7) Safety inspection.
- (8) Photographs and/or video

The daily inspection reports shall identify all QC inspections and QC tests conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

The daily inspection reports shall be signed by the responsible QC technician and the CQCPA. The DEN PM shall be provided at least one copy of each daily inspection report on the work day following the day of record. When QC inspection and test results are recorded and transmitted electronically, the results must be archived.

**b. Daily test reports.** The Contractor shall be responsible for establishing a system that will record all QC test results. Daily test reports shall document the following information:

- (1) Technical specification item number and description
- (2) Test designation
- (3) Location
- (4) Date of test
- (5) Control requirements
- (6) Test results
- (7) Causes for rejection
- (8) Recommended remedial actions
- (9) Retests

Test results from each day's work period shall be submitted to the DEN PM prior to the start of the next day's work period. When required by the technical specifications, the Contractor shall maintain statistical QC charts. When QC daily test results are recorded and transmitted electronically, the results must be archived.

**100-10 Corrective action requirements.** The CQCP shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process into control. The requirements for corrective action shall include both general requirements for operation of the CQCP as a whole, and for individual items of work contained in the technical specifications.

The CQCP shall detail how the results of QC inspections and tests will be used for determining the need for corrective action and shall contain clear rules to gauge when a process is out of control and the type of correction to be taken to regain process control.

When applicable or required by the technical specifications, the Contractor shall establish and use statistical QC charts for individual QC tests. The requirements for corrective action shall be linked to the control charts.

**100-11 Inspection and/or observations by the DEN PM.** All items of material and equipment are subject to inspection and/or observation by the DEN PM at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate QC system in conformance with the requirements detailed here and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place shall be subject to inspection and/or observation by the DEN PM at the site for the same purpose.

Inspection and/or observations by the DEN PM does not relieve the Contractor of performing QC inspections of either on-site or off-site Contractor's or subcontractor's work.

**100-12 Noncompliance.**

a. The Resident Project Representative (DEN PM) will provide written notice to the Contractor of any noncompliance with their CQCP. After receipt of such notice, the Contractor must take corrective action.

b. When QC activities do not comply with either the CQCP or the contract provisions or when the Contractor fails to properly operate and maintain an effective CQCP, and no effective corrective actions have been taken after notification of non-compliance, the DEN PM will recommend the Owner take the following actions:

- (1) Order the Contractor to replace ineffective or unqualified QC personnel or subcontractors and/or
- (2) Order the Contractor to stop operations until appropriate corrective actions are taken.

**METHOD OF MEASUREMENT**

**100-13 Basis of measurement and payment.** Contractor Quality Control Program (CQCP) is for the personnel, tests, facilities and documentation required to implement the CQCP. The CQCP will be paid as a lump sum with the following schedule of partial payments:

- a. With first pay request, 25% with approval of CQCP and completion of the Quality Control (QC)/Quality Assurance (QA) workshop.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 20%.
- d. When 75% or more of the original contract is earned, an additional 20%
- e. After final inspection and acceptance of project, the final 10%.

**BASIS OF PAYMENT**

**100-14 Payment will be made under:**

Item C-100-14.1 Contractor Quality Control Program (CQCP) – per lump sum

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

National Institute for Certification in Engineering Technologies (NICET)

ASTM International (ASTM)

ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D3665	Standard Practice for Random Sampling of Construction Materials

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM C-100 CONTRACTOR QUALITY CONTROL PROGRAM (CQCP)**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

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ASTM D3666

Standard Specification for Minimum Requirements for Agencies  
Testing and Inspecting Road and Paving Materials

**END OF ITEM C-100**

### Item C-105 Mobilization

**105-1 Description.** This item of work shall consist of, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project except as provided in the contract as separate pay items.

**105-2 Mobilization limit.** Mobilization shall be limited to 5 percent of the total project cost.

**105-3 Posted notices.** Prior to commencement of construction activities, the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor: Equal Employment Opportunity (EEO) Poster “Equal Employment Opportunity is the Law” in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL “Notice to All Employees” Poster; and Applicable Davis-Bacon Wage Rate Determination. These notices must remain posted until final acceptance of the work by the Owner.

### METHOD OF MEASUREMENT

**105-5 Basis of measurement and payment.** Based upon the contract lump sum price for “Mobilization” partial payments will be allowed as follows:

- a. With first pay request, 25%.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 40%.
- d. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation*, the final 10%.

### BASIS OF PAYMENT

**105-6 Payment will be made under:**

Item C-105-6.1	Mobilization – per lump sum
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### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Office of Federal Contract Compliance Programs (OFCCP)

Executive Order 11246, as amended

EEOC-P/E-1 – Equal Employment Opportunity is the Law Poster

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM C-105 MOBILIZATION**

**DENVER INTERNATIONAL AIRPORT  
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United States Department of Labor, Wage and Hour Division (WHD)

WH 1321 – Employee Rights under the Davis-Bacon Act Poster

**END OF ITEM C-105**

### **Item C-110 Method of Estimating Percentage of Material Within Specification Limits (PWL)**

**110-1 General.** When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (PWL), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average ( $\bar{X}$ ) and sample standard deviation ( $S_n$ ) of the specified number ( $n$ ) of sublots for the lot and the specification tolerance limits,  $L$  for lower and  $U$  for upper, for the particular acceptance parameter. From these values, the respective Quality index,  $Q_L$  for Lower Quality Index and/or  $Q_U$  for Upper Quality Index, is computed and the PWL for the lot for the specified  $n$  is determined from Table 1. All specification limits specified in the technical sections shall be absolute values. Test results used in the calculations shall be to the significant figure given in the test procedure.

There is some degree of uncertainty (risk) in the measurement for acceptance because only a small fraction of production material (the population) is sampled and tested. This uncertainty exists because all portions of the production material have the same probability to be randomly sampled. The Contractor's risk is the probability that material produced at the acceptable quality level is rejected or subjected to a pay adjustment. The Owner's risk is the probability that material produced at the rejectable quality level is accepted.

It is the intent of this section to inform the Contractor that, in order to consistently offset the Contractor's risk for material evaluated, production quality (using population average and population standard deviation) must be maintained at the acceptable quality specified or higher. In all cases, it is the responsibility of the Contractor to produce at quality levels that will meet the specified acceptance criteria when sampled and tested at the frequencies specified.

**110-2 Method for computing PWL.** The computational sequence for computing PWL is as follows:

- a. Divide the lot into  $n$  sublots in accordance with the acceptance requirements of the specification.
- b. Locate the random sampling position within the subplot in accordance with the requirements of the specification.
- c. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.
- d. Find the sample average ( $\bar{X}$ ) for all subplot test values within the lot by using the following formula:

$$\bar{X} = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where:  $\bar{X}$  = Sample average of all subplot test values within a lot

$x_1, x_2, \dots, x_n$  = Individual subplot test values

$n$  = Number of subplot test values

- e. Find the sample standard deviation ( $S_n$ ) by use of the following formula:

$$S_n = [(d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2)/(n-1)]^{1/2}$$

Where:  $S_n$  = Sample standard deviation of the number of subplot test values in the set  
 $d_1, d_2, \dots, d_n$  = Deviations of the individual subplot test values  $x_1, x_2, \dots$  from the average value  $X$

that is:  $d_1 = (x_1 - X), d_2 = (x_2 - X) \dots d_n = (x_n - X)$

$n$  = Number of subplot test values

**f.** For single sided specification limits (i.e., L only), compute the Lower Quality Index  $Q_L$  by use of the following formula:

$$Q_L = (X - L) / S_n$$

Where: L = specification lower tolerance limit

Estimate the percentage of material within limits (PWL) by entering Table 1 with  $Q_L$ , using the column appropriate to the total number ( $n$ ) of measurements. If the value of  $Q_L$  falls between values shown on the table, use the next higher value of PWL.

**g.** For double-sided specification limits (i.e., L and U), compute the Quality Indexes  $Q_L$  and  $Q_U$  by use of the following formulas:

$$Q_L = (X - L) / S_n$$

and

$$Q_U = (U - X) / S_n$$

Where: L and U = specification lower and upper tolerance limits

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table 1 separately with  $Q_L$  and  $Q_U$ , using the column appropriate to the total number ( $n$ ) of measurements, and determining the percent of material above  $P_L$  and percent of material below  $P_U$  for each tolerance limit. If the values of  $Q_L$  fall between values shown on the table, use the next higher value of  $P_L$  or  $P_U$ . Determine the PWL by use of the following formula:

$$PWL = (P_U + P_L) - 100$$

Where:  $P_L$  = percent within lower specification limit

$P_U$  = percent within upper specification limit

### EXAMPLE OF PWL CALCULATION

**Project:** Example Project

**Test Item:** Item P-401, Lot A.

#### A. PWL Determination for Mat Density.

1. Density of four random cores taken from Lot A.

A-1 = 96.60

A-2 = 97.55

A-3 = 99.30

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$$A-4 = 98.35$$

$$n = 4$$

2. Calculate average density for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$$

$$X = 97.95\% \text{ density}$$

3. Calculate the standard deviation for the lot.

$$S_n = [((96.60 - 97.95)^2 + (97.55 - 97.95)^2 + (99.30 - 97.95)^2 + (98.35 - 97.95)^2) / (4 - 1)]^{1/2}$$

$$S_n = [(1.82 + 0.16 + 1.82 + 0.16) / 3]^{1/2}$$

$$S_n = 1.15$$

4. Calculate the Lower Quality Index  $Q_L$  for the lot. ( $L=96.3$ )

$$Q_L = (X - L) / S_n$$

$$Q_L = (97.95 - 96.30) / 1.15$$

$$Q_L = 1.4348$$

5. Determine PWL by entering Table 1 with  $Q_L = 1.44$  and  $n = 4$ .

$$PWL = 98$$

**B. PWL Determination for Air Voids.**

1. Air Voids of four random samples taken from Lot A.

$$A-1 = 5.00$$

$$A-2 = 3.74$$

$$A-3 = 2.30$$

$$A-4 = 3.25$$

2. Calculate the average air voids for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$

$$X = 3.57\%$$

3. Calculate the standard deviation  $S_n$  for the lot.

$$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$$

$$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$$

$$S_n = 1.12$$

4. Calculate the Lower Quality Index  $Q_L$  for the lot. ( $L = 2.0$ )

$$Q_L = (X - L) / S_n$$

$$Q_L = (3.57 - 2.00) / 1.12$$

$$Q_L = 1.3992$$

5. Determine  $P_L$  by entering Table 1 with  $Q_L = 1.41$  and  $n = 4$ .

$$P_L = 97$$

6. Calculate the Upper Quality Index  $Q_U$  for the lot. ( $U = 5.0$ )

$$Q_U = (U - X) / S_n$$

$$Q_U = (5.00 - 3.57) / 1.12$$

$$Q_U = 1.2702$$

7. Determine  $P_U$  by entering Table 1 with  $Q_U = 1.29$  and  $n = 4$ .

$$P_U = 93$$

8. Calculate Air Voids PWL

$$PWL = (P_L + P_U) - 100$$

$$PWL = (97 + 93) - 100 = 90$$

### EXAMPLE OF OUTLIER CALCULATION (REFERENCE ASTM E178)

**Project:** Example Project

**Test Item:** Item P-401, Lot A.

#### A. Outlier Determination for Mat Density.

1. Density of four random cores taken from Lot A arranged in descending order.

$$A-3 = 99.30$$

$$A-4 = 98.35$$

$$A-2 = 97.55$$

$$A-1 = 96.60$$

2. From ASTM E178, Table 1, for  $n=4$  an upper 5% significance level, the critical value for test criterion = 1.463.

3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

a. For measurements greater than the average:

If (measurement - average)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-3, check if  $(99.30 - 97.95) / 1.15$  is greater than 1.463.

Since 1.174 is less than 1.463, the value is not an outlier.

b. For measurements less than the average:

If (average - measurement)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-1, check if  $(97.95 - 96.60) / 1.15$  is greater than 1.463.

Since 1.435 is less than 1.463, the value is not an outlier.

**Note:** In this example, a measurement would be considered an outlier if the density were:

$$\text{Greater than } (97.95 + 1.463 \times 1.15) = 99.63\%$$

OR

$$\text{less than } (97.95 - 1.463 \times 1.15) = 96.27\%.$$

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**Table 1. Table for Estimating Percent of Lot Within Limits (PWL)**

Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Positive Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4717	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1192	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9671	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5582	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4355	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4030	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0793	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Negative Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4355	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5582	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

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## **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM E178 Standard Practice for Dealing with Outlying Observations

**END OF ITEM C-110**

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## **Item P-101 Preparation/Removal of Existing Pavements**

### **DESCRIPTION**

**101-1** This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

### **EQUIPMENT AND MATERIALS**

**101-2** All equipment and materials shall be specified here and in the following paragraphs or approved by the DEN Project Manager (DEN PM). The equipment shall not cause damage to the pavement to remain in place.

### **CONSTRUCTION**

#### **101-3.1 Removal of existing pavement.**

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

**a. Concrete pavement removal.** When it is necessary to remove existing concrete pavement and leave adjacent concrete in place the joint between the removal area and adjoining pavement to stay in place shall first be cut full depth with a standard diamond-type concrete saw. Next, a full depth saw cut shall be made parallel to the joint at least 24 inches from the joint and at least 12 inches from the end of any dowels. All pavements between this last saw cut and the joint line shall be carefully broken up and removed using hand-held jackhammers, 30 lb. or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. The joint face shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2-inch and no gradual offset greater than 1 inch when tested in a horizontal direction with a 12 ft. straightedge. Sawcutting depth may vary nominally and no extra payment will be allotted for varying depths.

The Contractor shall remove the remaining portion of concrete pavement slab by lifting and placing directly into haul trucks. The Contractor will not be allowed to use hydraulic rams on excavators that may damage the cement treated base below the pavement to be removed in areas where demolition consists of slab removal only.

An alternative removal method may be accepted by the DEN PM if the Contractor can demonstrate to the DEN PM successful removal without damage to adjacent concrete or base material below. If during subsequent removals it is found the method is causing damage to the adjacent panels or base material below, the Contractor's method shall be rejected by the DEN PM and the DEN PM shall direct the Contractor to begin using the method above.

The Contractor's removal operation shall not cause damage to cables, utility ducts, pipelines, or drainage structures under the pavement. Concrete slabs that are damaged by under breaking shall be removed. Any damage shall be repaired at the Contractor's expense.

**(1) Edge Repair.** The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas which are damaged during construction shall be repaired at no cost to the Owner; repair of previously existing damage areas will be paid for as listed in the bid schedule.

**(2) Underbreak Repair.** Any under breaking of slabs that are to remain in-place shall result in the entire slab removal and replacement at the Contractor's expense to the next joint.

**(3) Underlying Material.** The underlying material adjacent to the edge of and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete and shall be shaped as shown on the plans or as directed. Sufficient material shall be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement which is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction, shall be carefully removed and replaced with concrete. The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed. If the disturbed material causes under breaking of concrete panels that are to remain in-place, it shall result in the entire slab removal and replacement at the Contractor's expense to the next joint.

**b. Existing Asphalt Pavement Removal and Repair by Milling.** This item shall consist of milling existing bituminous concrete pavement to allow for placement of sufficient thickness of bituminous concrete overlay for pavement repairs or construction on the runway or taxiway shoulders.

The vertical edges of the milled surface shall be sawcut to expose a clean true vertical edge to pave against.

All operations shall be carefully controlled to prevent damage to the asphalt pavement and to the underlying material to remain in place.

**c. Existing Full Depth Asphalt Pavement Removal.** This item shall consist of sawcutting and removal of existing bituminous concrete pavement (including Asphalt Treated Permeable Base (ATPB) to allow for replacement of P-501 slabs along the edges adjacent to asphalt shoulders. A standard diamond-type concrete saw shall be used to make the sawcut the full depth of the asphalt pavement (including ATPB). The pavement shall be removed so the joint for each layer of pavement replacement is offset 1 foot from the joint in the preceding layer. This does not apply if the removed pavement is to be replaced with concrete or soil.

The edge of existing bituminous concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas which are damaged during construction shall be repaired at no cost to the Owner.

All operations shall be carefully controlled to prevent damage to the asphalt pavement and to the underlying material to remain in place.

**101-3.2 Preparation of joints and cracks prior to overlay/surface treatment.** Remove all vegetation and debris from cracks to a minimum depth of 1 inch (25 mm). If extensive vegetation exists, treat the specific area with a concentrated solution of a water-based herbicide approved by the DEN PM. Fill all cracks greater than 1/4 inch (6 mm) wide) with a crack sealant per ASTM D6690. The crack sealant, preparation, and application shall be compatible with the

surface treatment/overlay to be used. To minimize contamination of the asphalt with the crack sealant, underfill the crack sealant a minimum of 1/8 inch (3 mm), not to exceed ¼ inch (6 mm). Any excess joint or crack sealer shall be removed from the pavement surface.

**101-3.3 Removal of Foreign Substances/contaminates prior to remarking.** Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as directed by the DEN PM in the field during construction.

High-pressure water and rotary grinding may be used. If chemicals are used, they shall comply with the state's environmental protection regulations. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch (3 mm) deep. If it is deemed by the DEN PM that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as directed by the DEN PM.

The water blasting equipment shall be truck mounted and shall be capable of water pressures of 2,000 to 40,000 psi. The equipment shall be capable of adjusting the pressure to accomplish paint or cure removal without damaging the paving surface. The equipment shall be capable of following a straight line and be maneuverable to accommodate various pavement markings. The spray width needs to be able to accommodate lines 6" and wider. If water blasting is used to remove lines on active airfield pavements, a vacuum system will be provided to allow for timely repainting and the prevention of any debris being ingested into propellers or turbine engines once the water blasting equipment has exited the active pavements.

If required on asphalt pavement, the grinding equipment shall be capable of adjusting the height to accomplish paint removal with only lightly scaring, but not damaging the paving surface. The equipment shall be capable of following a straight line and be maneuverable to accommodate various pavement markings. A vacuum truck shall be used to immediately clean up all debris created by the removal process.

Removal of foreign substances shall not proceed until approved by the DEN PM. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans or disposed off-site legally.

**101-3.4 Concrete spall or failed asphaltic concrete pavement repair.**

**a. Spall Repair.** Spalls shall be repaired where indicated and where directed. Repair materials and procedures shall be completed as required in Item P-501.

**101-3.5 Cold milling.** Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The vertical edges of the milled surface shall be sawcut to expose a clean true vertical edge to pave against. The milling machine or grinder shall operate without tearing or gouging the underlying surface. The milling machine or grinder shall be equipped with grade and slope controls, and a positive means of dust control. All millings shall be removed and disposed in areas designated on the plans. If the Contractor mills or grinds deeper or wider than the plans specify, the Contractor shall replace the material removed with new material at the Contractor's Expense.

**a. Patching.** The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of

controlling the depth of cut. The DEN PM shall layout the area to be milled with a straightedge in increments of 1-foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn't have the appropriate milling machine, or areas that are damaged because of his negligence, shall be repaired by the Contractor at the Contractor's Expense.

**b. Profiling, grade correction, or surface correction.** The milling machine shall have a minimum width of 7 feet and it shall be equipped with electronic grade control devices that will cut the surface to the grade specified. The tolerances shall be maintained within +0 inch and -1/4 inch (+0 mm and -6mm) of the specified grade. The machine must cut vertical edges and have a positive method of dust control. The machine must have the ability to remove the millings or cuttings from the pavement and load them into a truck. All millings shall be removed and disposed of in areas designated on the plans.

**c. Clean-up.** The Contractor shall sweep the milled surface daily and immediately after the milling until all residual materials are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove loose residual material. Waste materials shall be collected and removed from the pavement surface and adjacent areas by sweeping or vacuuming. Waste materials shall be removed and disposed in areas designated on the plans.

**101-3.6. Preparation of asphalt pavement surfaces prior to surface treatment.** Existing asphalt pavements to be treated with a surface treatment shall be prepared as follows:

**a.** Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt pavement similar to that of the existing pavement in accordance with paragraph 101-3.4b.

**b.** Repair joints and cracks in accordance with paragraph 101-3.2.

**c.** Remove oil or grease that has not penetrated the asphalt pavement by scrubbing with a detergent and washing thoroughly with clean water. After cleaning, treat these areas with an oil spot primer.

**d.** Clean pavement surface immediately prior to placing the surface treatment so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film.

**101-3.7 Maintenance.** The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the DEN PM. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor's expense.

**101-3.8 Preparation of Joints in Rigid Pavement prior to resealing.** Not used.

**101-3.8.1 Removal of Existing Joint Sealant.** Not used.

**101-3.8.2 Cleaning prior to sealing.** Not used.

**101-3.8.3 Joint sealant.** Not used..

**101-3.9 Preparation of Cracks in Flexible Pavement prior to sealing.** Not used.

**101-3.9.1 Preparation of Crack.** Not used.

**101-3.9.2 Removal of Existing Crack Sealant.** Not used.

**101-3.9.3 Crack Sealant.** Not used,

**101-3.9.4 Removal of Pipe and other Buried Structures.**

**a. Removal of Existing Pipe Material.** Contractor is responsible to contact the owner as to the status of the pipeline. If pipelines have been abandoned in-place by the pipeline owners, the pipelines may not have been purged or cleaned and may contain petroleum products. The contractor shall exercise extreme care in removing these facilities and is responsible for removing the pipe including any remaining contents, irrespective of the current pipe conditions. The Contractor should also expect to find other pipelines, etc. which have been abandoned by unknown owners during the 15 to 20-year life of the oil and gas fields. Contract documents indicate the general location of known pipelines and developed utilities. All pipelines shown on the plans shall be located by Contractor by potholing to verify location, depth, and usage. The Contractor shall remove all utility pipes and lines included in the earthwork contract area in accordance with these specifications. All buried pipelines, utilities, buried tanks, and any other structures within the construction area of all runways, taxiways and aprons extending to 10 feet (3 m) outside the limits of construction shall be removed. The Contractor shall notify oil and gas facility owners and the DEN Project Manager in writing 30 days in advance of requiring work in areas currently occupied by oil and gas wells and buried pipelines.

The ends of any pipelines left in place shall have the ends capped prior to burial, according to applicable Federal Department of Transportation Regulations. Any piping which is left in place shall be surveyed and the coordinates of the ends of the abandoned pipe (or other items left in place) shall be provided to the DEN Project Manager and included on the "as-built" drawings."

Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off-site in a timely manner following removal. Trenches shall be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 95% of ASTM D1557.

**b. Removal of Inlets/Manholes.** Where indicated on the plans or as directed by the DEN PM, inlets, and/or manholes shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas cohesive soil must be compacted to 95% of ASTM D1557, when outside of paved areas cohesive soil must be compacted to 95% of ASTM D698.

**c. Removal of Electrical.** The Contractor shall remove all abandoned cable, cable identified to be removed, ductwork, base cans including concrete encasement and all light fixtures, signs, electrical ground wells, and duct markers within the construction limits of taxiway and runway pavements to be removed, widened or constructed, or as shown on the Plans. Protect existing airfield lighting fixtures and base plates from damage and deliver them to the Airport for storage as directed by the DEN Project Manager. Discard all base cans, conduit, transformers and cable off-site. The Electrical Contractor shall provide written documentation to the DEN Project Manager that electrical cable has been removed prior to slab sawcutting and demolition.

**d. Foundations and Slabs on Grade.** Where indicated on the Plans or as directed by the DEN PM, all structures at or above grade and within 10 feet horizontally of the construction limits shall be removed.

**e. Removal of Oil/Water Separator Tank.** Contractor shall remove 50,000 gallon steel oil/water separator tank that is approximately 12 feet in diameter and 59 feet long.

**f. Removal of Existing Riprap.** Remove and dispose of the existing riprap section, including and base or fabric material, Dispose of non-aggregate material off site and dispose of rock and any other soil associated with said removal as directed by the DEN PM.

**g. Removal of Water Quality Structure.** The Contractor shall remove water quality concrete structure, including separate water quality inlet, and backfill as applicable to create required foundational material for new facilities being constructed in this place, per demolition Plans and/or as directed by the DEN PM. Contractor shall be responsible for any removal, hauling and disposal fees.

**h. Removal of High Mast Lighting.** The Contractor shall remove existing apron mast lighting, above grade pullbox, adjacent bollards and foundations as depicted on the Plans without damaging any of the poles or fixtures. Return material to a DEN location as directed by the DEN PM.

**i. Removal of Existing Engine Block Heater Rack.** Remove and salvage engine block heater rack as depicted on the Plans. Return material to a DEN location as directed by the DEN PM.

**j. Remove Underdrain Pipe and Cleanouts.** Remove as depicted on the Plans and backfill in accordance with Item P-152 and/or typical sections, whichever are applicable.

**k. Removal of Headwall, Wingwalls and End Sections.** Remove as depicted on the Plans and dispose of at a DEN location as directed by the DEN PM.

**l. Removal of DIW Force Main.** Contractor shall coordinate depressurization of DIW Force Main with DEN PM and applicable DEN personnel prior to commencement of this demolition activity. Materials removed shall be disposed of off-site and excavation backfilled in accordance with Item P-152, applicable typical sections and/or directed by the DEN PM.

### **METHOD OF MEASUREMENT**

**101-4.1 Lump sum items.** Items indicated as lump sum will be paid at the agreed upon bid lump sum price in partial payments based on a schedule of values determined by the DEN PM.

**101-4.2 Pavement removal.** The unit of measurement for pavement removal shall be the number of square yards removed by the Contractor and accepted by the DEN PM. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to pavement removal. Dowel bar and bond breaker removal shall be incidental to pavement removal.

Pavement removal indicated as “Full Depth” includes the removal of all structural layers below the top pavement surface. Any soil cement removed outside of the designed limits of removal because the soil-cement or aggregate-cement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment.

Pavement removal indicated as “Slab Only” includes the top rigid pavement layer only. Any removal of structural layers below the top pavement surface will be considered outside of the designed limits of removal by negligence on the part of the Contractor. Damaged structural layers shall be repaired by the Contractor at no cost to the owner and shall not be measured for payment.

The thickness of the existing material to be removed is approximate only and the Contractor will not be reimbursed for areas that may be thicker than shown on the plans. Removal of pavement shall include all sawcutting, excavation, hauling, and disposal (including disposal fees) of materials to facilitate removal.

**101-4.3 Cold milling.** The unit of measure for cold milling shall be per square yard. The location and average depth of the cold milling shall be as shown on the Plans. If the initial cut does not correct the condition, the Contractor shall re-mill the area and will be paid for the total depth of milling indicated.

**101-4.4 Removal of Pipe.** The length of pipe to be removed shall be measured in its original position along the centerline of the pipe from end or inside faced of the structure(s) or end of pipe with no structure present. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**101-4.5 Removal of Buried Structures.** The unit of measurement for buried structures, such as the oil/water separator tank, water quality structure, ground well and flared end section, will be per each. Other work required, such as off-site disposal and backfilling, shall be considered as a subsidiary obligation of the Contractor and covered under the bid item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**101-4.6– Remove Underdrain Cleanout.** Measurement for payment for the removal of existing underdrain cleanouts and associated pipe and fittings shall be made per each. Any pipe removed outside the preapproved limits of removal because the pipe was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. The removal of underdrain cleanouts shall include concrete, reinforcing, and capping the end of the existing underdrain to remain. The remains shall be disposed of off-site.

**101-4.7 – Removal of Manholes.** Measurement for payment of the removal of existing manholes and associated pipe and fittings shall be made per each. Any pipe removed outside the preapproved limits of removal because the pipe was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. The removal of underdrain manholes shall include concrete, reinforcing, and capping the end of the existing pipe to remain. The removed material shall be disposed of off-site.

**101-4.8 - Remove Underdrain Pipe (Complete).** Measurement for payment for removal of existing underdrain pipe and associated fittings shall be made per linear foot. Any pipe removed outside the preapproved limits of removal because the pipe was damaged due to negligence on the part of the Contractor shall not be included in the measurement for payment. The removal of underdrains shall include piping, porous backfill, filter fabric, concrete and capping the end of the existing underdrain to remain. Removed material shall be disposed of off-site.

**101-4.9 - Remove Underdrain Cleanout (Complete).** Measurement for payment of the removal of underdrain cleanouts and associated fittings, components including encasement material shall be made per each. Any pipe removed outside the preapproved limits of removal because the pipe was damaged due to negligence on the part of the Contractor shall be replaced by the Contractor, in kind, at no cost to DEN. Removal of underdrain cleanouts shall include piping, backfill, filter fabric and any encasement material such as concrete and flowfill and capping the end of the existing underdrain to remain. Removed material shall be disposed of off-site.

**101-4.10 Remove Existing Grouted Riprap.** Measurement for payment of Remove Existing Grouted Rip Rap shall be made per square yard based on the area approved for removal by

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DEN and actually removed during construction. The thickness of the existing material to be removed is approximate only and the Contractor will not be reimbursed for areas that may be thicker than shown on the plans. Remove Existing Grouted Rip Rap shall include all breaking, excavation, hauling, cleaning and/or disposal (including disposal fees) of rip rap material necessary to facilitate removal and/or reuse of the material on site.

**101-4.11 Removal of Electrical Items.** The unit of measurement for removal of lights, electrical ground wells, junction boxes, electrical manholes, signs, and other miscellaneous electrical items will be made at the contract unit price for each completed and accepted item, including foundations. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**BASIS OF PAYMENT**

**101-5.1 Payment.** Payment shall be made at contract unit price for the unit of measurement as specified above. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

P-101-5.1	Remove Concrete Pavement - 17" Non-Reinforced (Full Depth)	- per square yard
P-101-5.2	Remove Concrete Pavement - 17" Reinforced (Full Depth)	- per square yard
P-101-5.3	Remove Concrete Pavement - 17" Non-Reinforced (Slab Only)	- per square yard
P-101-5.4	Remove Bituminous Taxiway Shoulder Pavement - 10" (Full Depth)	- per square yard
P-101-5.5	Remove VSR Bituminous Pavement - 10" (Full Depth)	- per square yard
P-101-5.6	Remove VSR Bituminous Pavement - 8" (Full Depth)	- per square yard
P-101-5.7	Remove Roller Compacted Concrete Pavement - 8" (Full Depth)	- per square yard
P-101-5.8	Remove Concrete Pavement - 6" (Full Depth)	- per square yard
P-101-5.9	Cold Milling - 3" Depth	- per square yard
P-101-5.10	Remove 12-Inch Steel Pipe	- per linear feet
P-101-5.11	Remove 18-Inch RCP Drainage Pipe	- per linear feet
P-101-5.12	Remove 24-Inch PVC Drainage Pipe	- per linear feet
P-101-5.13	Remove 24-Inch RCP Drainage Pipe	- per linear feet
P-101-5.14	Remove 30-Inch RCP Drainage Pipe	- per linear feet
P-101-5.15	Remove 54-Inch RCP Drainage Pipe	- per linear feet
P-101-5.16	Remove 60-Inch RCP Drainage Pipe	- per linear feet

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P-101-5.17	Remove Underdrain Pipe	- per linear feet
P-101-5.18	Remove Underdrain Cleanout	- per each
P-101-5.19	Remove SDG Manhole/Inlet	- per each
P-101-5.20	Remove DIW Manhole/Inlet	- per each
P-101-5.21	Remove DIW Force Main Manhole	- per each
P-101-5.22	Removal of Headwall and Wingwalls	- per each
P-101-5.23	Remove Flared End Section	- per each
P-101-5.24	Remove Existing Riprap	- per square yard
P-101-5.25	Remove 50,000 Gallon Steel Oil/Water Separator Tank	- per lump sum
P-101-5.26	Remove Electrical Ground Well	- per each
P-101-5.27	Remove Water Quality Structure	- per each
P-101-5.28	Remove DIW Force Main 8" PVC Pipe	- per linear feet
P-101-5.30	Remove Electrical Handhole	- per each
P-101-5.31	Remove Elevated Light and Base Can, Complete	- per each
P-101-5.32	Remove In-Pavement Light and Base Can, Complete	- per each
P-101-5.33	Remove SRE Receptacle Panelboard, Transformer, and Foundation, Complete	- per lump sum
P-101-5.34	Remove SRE Engine Block Heater Receptacle Rack	- per lump sum
P-101-5.35	Remove High Mast Light Pole and Foundation, Complete	- per each
P-101-5.36	Remove Guidance Sign and Foundation	- per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

**END OF ITEM P-101**

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## Item P-152 Excavation, Subgrade, and Embankment

### DESCRIPTION

**152-1.1** This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas; as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

**152-1.2 Classification.** All material excavated shall be classified as defined below:

- a. Unclassified excavation.** Unclassified excavation shall consist of the excavation and placement of all material, regardless of its nature, which is not otherwise classified and paid for under one of the items listed in Sections 152-1.2 and 152-1.3. Unclassified Excavation shall consist of material cut within the project construction limits and placed within the construction limits as embankment or structural fill. Unclassified Excavation includes, as incidental to the work, any required import material to fill voids beneath the proposed pavement section for purposes of backfilling utility and structure excavations.
- b. Borrow excavation.** Borrow excavation shall consist of approved imported Lower Select Embankment Material, and approved imported Upper Select Embankment material required for the construction of the P-220 Cement-Treated Soil Base Course. Borrow material shall be obtained from areas designated by the DEN Project Manager (DEN PM), within the limits of the Airport property, but outside the normal limits of necessary grading, or from areas outside the Airport. Borrow Embankment shall be verified to meet the requirements of P-152-1.4, in accordance with P-152-1.5, prior to placement on-site as embankment fill.
- c. Waste Excavation.** Waste Excavation shall consist of either (1) over-excavated existing native subgrade soils or (2) DEN Select Material (beneath the existing lime-treated subgrade), which are in excess of that needed for new pavement section construction.
  - Waste Excavation (1) is the volumetric difference of material which is cut between the native material surface, following stripping and topsoil removals, and the bottom of the imported Lower Select material.
  - Waste Excavation (2) is the volumetric difference of material which is cut between the bottom of the existing lime-treated subgrade and the bottom of the imported Upper-Select material. Waste Excavation (2) shall consist of materials beneath existing PCCP pavement sections, which meet the requirements of DEN Select Embankment and which are found to be uncontaminated and suitable, following required in-place testing by the Contractor of these materials.

Waste Excavation material shall be placed in the Unsuitable Soil Disposal Area noted on the Plans. Waste Excavation materials shall be placed, graded, and compacted on Airport Property, as designated by the DEN PM, in accordance with the requirements of P-152-2.12. Alternatively, the material may simply be stockpiled, at the discretion of the DEN PM.

- d. Common Embankment.** Common Embankment shall consist of material which is not contaminated, is not deemed “Unsuitable,” and is not classified as defined above, to exclude topsoil material and rock excavation.

**152-1.3 Unsuitable excavation.** Unsuitable material shall be disposed in designated waste areas, as shown on the plans. Materials containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material suitable for topsoil may be used on the embankment slope, when approved by the DEN PM.

Material found to contain contaminants or hazardous materials shall be handled in accordance with the provisions of Section 017419 – *Construction Waste Management and Disposal*. Excavation. Disposal of contaminated soils shall be measured and paid for as incidental to “Unclassified Excavation – Export to Waste Area.”

**152-1.4 Select Embankment.** Select Embankment shall consist of material, as described below.

- Lower-Select Embankment: the lower 4.5-feet of embankment fill.
- Upper-Select Embankment: the upper 1.5-feet of embankment fill.

The upper 12-inches of the Upper-Select Embankment will be cement-treated, in accordance with Item P-220 Cement-Treated Soil Base Course.

**a. Lower-Select Embankment.** Lower-Select Embankment material shall consist of existing in-place select fill under existing pavement sections (found to be “suitable”) or material sourced from approved borrow sources on the Airport. Moisture conditioning of in-place existing Lower-Select fill shall be performed to a depth of 8 to 12-inches below planned finished grades or to 3-feet below existing site grades (DEN frost depth), whichever is greater.

Over-excavation and replacement of existing soils to 3-feet below existing site grades (DEN frost depth) shall be completed to a maximum 12-inch lift thickness. Reconditioning of the native Lower Select material will be performed to a depth of either 8-inches or 12-inches, depending on the on-site condition of the soils. In-situ materials which are undisturbed through construction activities will be reconditioned in-place to a depth of 8-inches. Material which is found to be unsuitable (P-152-1.3) will be excavated and replaced with import material to a depth of 12-inches. Materials which are disturbed due to construction activities (utility repair trenches etc.) will be reconditioned to a depth of 12-inches. Reconditioning that is to take place in confined spaces which limit access by heavy equipment shall be reconditioned to a depth of 8-inches. All existing Lower Select soils shall be reconditioned to achieve optimum moisture/density, regardless of depth and location, to provide for minimized swell potential upon exposure to subsurface moisture.

Imported Lower-Select Embankment materials shall be free of unsuitable materials (including claystone), contain 100% passing the 3-inch sieve, less than 90% passing the No. 200 sieve, and less than 3% swell potential. The swell sample shall be remolded to 95% of the maximum dry density at optimum moisture and wetted while under 200 psf surcharge, as determined by ASTM D 698 for initial acceptance of the proposed imported Lower-Select Embankment Material. During placement of the imported Lower-Select Embankment Material, the swell sample shall be obtained from the compacted in-place imported Lower Select Embankment Material.

Lower-Select Embankment materials should be properly moisture-conditioned and compacted, in accordance with this specification.

**b. Upper-Select Embankment.** Upper-Select Embankment material shall be obtained from the borrow area(s) indicated in the Plans, and tested to be certified free of contaminants. Upper-Select Embankment material, of which the upper 12-inches will be cement-treated per Item P-

220, shall be an imported material free of unsuitable materials, with 100% passing the 1-inch sieve, no more than 45% retained on a No. 4 sieve, less than 70% passing the No. 200 sieve, a maximum water soluble sulfates content of 0.5%, and less than 3% swell potential. The swell sample shall be remolded to 95% of the maximum dry density at optimum moisture and wetted while under 200 psf surcharge, as determined by ASTM D 698 for initial acceptance of the proposed Upper-Select Embankment material.

During placement of the Upper-Select Embankment material, the swell sample shall be obtained from the compacted in-place Upper-Select Embankment material. Upper-Select Embankment materials shall be properly moisture-conditioned and compacted, in accordance with this specification.

**152-1.5 Material Classification.** Non-cohesive soils, for the purposes of determining compaction control, are those with a Plasticity Index (PI) of less than 3, when tested in accordance with ASTM D 4318. Any other material shall be considered cohesive.

### **CONSTRUCTION METHODS**

**152-2.1 General.** Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with contract and as approved by the DEN PM. This work shall be measured and paid for as incidental to the associated work items.

The suitability of material to be placed in embankments shall be subject to approval by the DEN PM. All unsuitable material shall be disposed of in waste areas as shown on the plans. All waste areas shall be graded to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas shall be specified on the plans or approved by the DEN PM.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued, and the DEN PM notified per Section 70, paragraph 70-20. At the direction of the DEN PM, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4-inches, (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6-inches (150 mm) of the subgrade.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the DEN PM, who shall arrange for their removal if necessary. The Contractor, at their own expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

**a. Blasting.** Blasting shall not be allowed.

**152-2.2 Excavation.** No excavation shall be started until the work has been staked out by the Contractor, and the DEN PM has obtained from the Contractor the survey notes of the elevations and measurements of the ground surface. The Contractor and DEN PM shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

Digital terrain model (DTM) files of the existing surfaces, finished surfaces, and other various surfaces were used to develop the design plans. Volumetric quantities were calculated by comparing DTM files of the applicable design surfaces and generating Triangle Volume Reports. Electronic copies of DTM files will be issued to the successful bidder.

Existing grades on the DTMs, where they do not match the locations of actual spot elevations shown on the topographic map, were developed by computer interpolation from those spot elevations. Prior to disturbing original grade, Contractor shall verify the accuracy of the existing ground surface by verifying spot elevations at the same locations where original field survey data was obtained as indicated on the topographic map. Contractor shall recognize that, due to the interpolation process, the actual ground surface at any particular location may differ somewhat from the interpolated surface shown on the design cross sections or obtained from the DTM's. Contractor's verification of original ground surface, however, shall be limited to verification of spot elevations as indicated herein, and no adjustments will be made to the original ground surface, unless the Contractor demonstrates that spot elevations shown are incorrect. For this purpose, spot elevations which are within 0.1 foot of the stated elevations for ground surfaces, or within 0.04 foot for hard surfaces (pavements, buildings, foundations, structures, etc.) shall be considered "no change". Only deviations in excess of these will be considered for adjustment of the original ground surface. If the Contractor's verification identifies discrepancies in the topographic map, Contractor shall notify the DEN PM in writing at least two weeks before disturbance of existing grade, to allow sufficient time to verify the submitted information and make adjustments to the design cross sections or DTM's. Disturbance of existing grade in any area shall constitute acceptance by the Contractor of the accuracy of the original elevations shown on the topographic map for that area.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the DEN PM. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes as shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the DEN PM. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes as shown on the plans. All Unsuitable Material shall be disposed of as outlined in P-152-1.3.

The grade shall be maintained so that the surface is well drained at all times.

When the volume of the excavation exceeds that required to construct the embankments to the grades as indicated on the plans, the excess shall be used to grade the areas of ultimate development or disposed as directed by the DEN PM. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from pre-approved borrow areas, as indicated on the Plans.

- a. Selective grading.** When selective grading is indicated on the plans, the more suitable material designated by the DEN PM shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved, and no separate measurement or payment shall be made for this work.
- b. Undercutting.** Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be

excavated to a minimum depth of 12-inches below the subgrade or to the depth specified by the DEN PM. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed of at locations shown on the plans and as indicated in P-152-1.3. This excavated material shall be paid for at the contract unit price per cubic yard for “Unclassified Excavation – Export to Waste Area”. The excavated area shall be backfilled in accordance with specification provisions with suitable material obtained from the grading operations or borrow areas. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with lower select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans. Undercutting will be paid as “Unclassified Excavation – Export to Waste Area.”

- c. Over-break.** Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the DEN PM. All over-break shall be graded or removed by the Contractor and disposed of as directed by the DEN PM. The DEN PM shall determine if the displacement of such material was unavoidable and their own decision shall be final. Payment will not be made for the removal and disposal of over-break that the DEN PM determines as avoidable. Unavoidable over-break will be classified as “Unclassified Excavation – Export to Waste Area.”
- d. Removal of utilities.** The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by the Contractor, as indicated on the plans. All existing foundations shall be excavated at least 2-feet below the top of subgrade, or as indicated on the plans, and the material disposed of as directed by the DEN PM. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

**152-2.3 Borrow excavation.** Borrow areas within the Airport property are indicated on the plans. Borrow excavation shall be made only at these designated locations and within the horizontal and vertical limits as staked, or as directed by the DEN PM. All unsuitable material shall be disposed of by the Contractor as shown on the plans and as outlined in P-152-1.3. All borrow pits shall be opened to expose the various strata of acceptable material to allow obtaining a uniform product. Borrow areas shall be drained and left in a neat, presentable condition with all slopes dressed uniformly. Borrow areas shall not create a wildlife attractant.

The Contractor shall identify borrow sources to distinguish materials to be used as select embankment. The Contractor shall prepare a Select Embankment Material Plan for select material excavation and select material placement, based on the plan information and the Contractor's further exploration of select embankment material availability.

The Select Embankment Material Plan shall contain the results of the following investigation:

- a.** Select Borrow investigation for designated areas.
- b.** Test hole or pit explorations in select borrow areas at approximately 300-foot on center.
- c.** Sample testing at each exploration for depth of topsoil, depth of select material, elevation of surface, and laboratory tests for Plasticity Index, sieve analysis, percent passing 200 sieve, classification, soluble sulfates, and swell consolidation. All materials shall be tested for the presence of contaminants and hazardous materials. All soils testing shall be paid for as incidental to the work.
- d.** Detailed log of each test hole or pit.
- e.** Estimate of select material available in each area.

When borrow sources are outside the boundaries of the airport property, it shall be the Contractor's responsibility to locate and obtain the borrow source, subject to the approval of the DEN PM. The Contractor shall notify the DEN PM at least 15 days prior to beginning the excavation, so necessary measurements and tests can be made. All borrow pits shall be opened up to expose the various strata of acceptable material to allow obtaining a uniform product. All unsuitable material shall be disposed of by the Contractor. Borrow pits shall be excavated to regular lines to permit accurate measurements, and they shall be drained and left in a neat, presentable condition, with all slopes dressed uniformly.

**152-2.4 Drainage excavation.** Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the DEN PM. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted. Work performed under this section shall be considered incidental to the project, and will not be measured or paid separately.

**152-2.5 Hazardous Materials.** Some material (equipment, debris, soil, wastes, etc.) may be affected by hazardous constituents, chemicals or compounds used during oil and gas production, residential development, public improvement construction, or agricultural use. Material contaminated or potentially contaminated with hazardous constituents, chemicals, or compounds shall be assessed by the Contractor regarding the hazardous characteristic(s) of each material. The assessment will be made in accordance with requirements specified by the Colorado Department of Public Health and Environment (CDPHE) and the Colorado Department of Natural Resources Oil and Gas Conservation Commission (OGCC). The Contractor shall notify the Engineer in writing immediately upon discovery or suspicion of the existence of such hazardous material. See Section 015719 for further requirements regarding identification and remediation of contaminated soils.

Material found to contain contaminants or hazardous materials shall be handled in accordance with the provisions of Section 017419.

**152-2.6 Preparation of cut areas or areas where existing pavement has been removed.** In those areas on which a subbase or base course is to be placed, the top 12-inches of subgrade shall be conditioned to optimum moisture and 95% of maximum density, as determined by ASTM D698.

**a. Subgrade Bridging.** Following removal of overburden (concrete pavement panels and underlying cement-treated base and lime-treated subgrade materials, or native soils in previously undeveloped areas to the depth of the bottom of the Lower Select Embankment), exploratory potholes shall be excavated to evaluate the composition and depth of any unstable or unsuitable material. The exploratory activities shall be performed using equipment that will minimize disturbance of underlying soft soils.

If there is no unstable or unsuitable material, the ground surface shall be scarified to the depth specified in P-152-1.4, moisture conditioned to within 2% of the optimum moisture content, and compacted to 95% of the ASTM D 698 maximum dry density. This work shall be measured and paid for as incidental to "Subgrade Remediation."

If unsuitable or unstable materials are identified at the depth of the bottom of proposed Lower Select Embankment fill, the excavated surface may be stabilized using 3-inch to 8-inch “bridging material” (recycled concrete crushed aggregate). Stabilization shall consist of first spreading an 18-inch thick lift of bridging material over the soft subgrade by pushing the material out over the soft subgrade in front of a piece of tracked equipment, or low ground pressure (LGP) tracked equipment as necessary, to avoid disturbance of the underlying soft soil. Additional lifts shall be spread and track-compacted as required to provide a sufficiently stable surface upon which to place the initial lift of embankment fill. Only the minimum thickness of bridging material necessary to provide a stable embankment foundation shall be used.

At the discretion of the DEN PM to ensure timely progress of the work, unsuitable or unstable native embankment materials may be bridged, in lieu of (1) removed to stable material and replaced with suitable lower embankment or (2) or reconditioned in-place, as described above. Unsuitable or unstable subgrade materials shall be reconditioned and mechanically stabilized (“bridged”) in lifts not-to-exceed 18-inches. Mechanical bridge stabilization may require application in several lifts to treat the affected area. Following mechanical stabilization, the area shall be proof-rolled in accordance with P-152-2.13 and approved by the DEN PM.

As an alternative to using the coarse-grained bridging material, a geogrid or geotextile stabilization fabric may be placed on the undisturbed soft subgrade and covered with a layer of finer ( $\frac{3}{4}$ -inch to 1½-inch) crushed concrete or aggregate using procedures similar to those described above for the “bridging material”. A bi-axial Type 2 geogrid or a stabilization geotextile meeting the requirements of strength Class 1 according to AASHTO M 288 shall be installed. Subgrade bridging methodology and materials shall be approved by the DEN PM, prior to implementation. Subgrade Bridging shall be measured and paid for as “Subgrade Bridging (18-inches),” as required via contract amendment.

**152-2.7 Preparation of embankment area.** All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 12-inches and shall then be compacted per P-152-2.12.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12-inches and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

**152-2.8 Control Strip.** The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the DEN PM, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12-inches upon the Contractor’s demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The DEN PM must witness this demonstration and approve the lift thickness, prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the DEN PM. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the DEN PM.

**152-2.9 Formation of embankments.** The material shall be constructed in lifts as established in the control strip, but not less than 6 inches nor more than 12-inches of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts, until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact, and re-test any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section, or as directed by the DEN PM. Materials such as brush, hedge, roots, stumps, grass, and other organic matter shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained, due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment, nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within +0% to +2% of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The Contractor shall take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D698. A new Proctor shall be developed for each soil type, as determined by the procedures outlined in P-152-1.5.

Density tests will be taken by the Contractor for every 3,000 square yards of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies as determined by the DEN PM.

If the material has greater than 30% retained on the 3/4-inch sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than 100% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D968. Under all areas to be paved, the embankments shall be compacted to a depth of 12-inches and to a density of not less than 95% percent of the maximum density as determined by ASTM D698.

On all areas outside of the pavement areas, no compaction will be required on the top 4-inches, which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with ASTM D1556 or ASTM 6938 using Procedure A, the direct transmission method. ASTM D6938 shall be used to determine

the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The Contractor's laboratory shall perform all density tests in the presence of the DEN PM and provide the test results upon completion to the DEN PM for acceptance. If the specified density is not attained, the area represented by the test or as designated by the DEN PM shall be re-worked and/or re-compacted and additional random tests shall be made. This procedure shall be followed until the specified density is reached.

Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained and is approved by the DEN PM.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment, as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4-inches in their greatest dimensions will not be allowed in the top 12-inches of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the DEN PM and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the DEN PM.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in lifts of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in lifts not exceeding 2-feet in thickness. Each lift shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The lift shall not be constructed above an elevation 4-feet below the finished subgrade.

Payment for compacted embankment will be made under "Unclassified Excavation – Embank On-Site."

**152-2.10 Proof rolling.** The purpose of proof-rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. After compaction is completed, the subgrade area shall be proof-rolled with a 20-ton Tandem-Axle Dual-Wheel Dump Truck loaded to the legal limit with tires inflated to 125 psi or a 15-ton Proof Roller with tires spaced not more than 32-inches on-center with tires inflated to 125 psi, in the presence of the DEN PM. Apply a minimum of 4 coverages, or as specified by the DEN PM, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1-inch, or show permanent deformation greater than 1-inch, shall be removed and replaced with suitable material or re-worked to conform to the moisture content and compaction requirements, in accordance with these specifications. Removal and replacement of soft areas is incidental to the work, and shall not be measured or paid for separately.

**152-2.11 Compaction requirements.** The subgrade under areas to be paved shall be compacted to a depth of 12-inches (8-inches, if Contractor cannot demonstrate competent result, per P-152-2.8 Control Strip) and to a density of not less than 100 percent of the maximum density for non-cohesive soils and 95 percent of the maximum dry density for cohesive soils as determined by ASTM D698. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12-inches and to a density of not less than 95 percent of the

maximum density for non-cohesive soils and 90 percent of the maximum density for cohesive soils as determined by ASTM D698.

The material to be compacted shall be within +0% to +2% of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the ¾ inch sieve, follow the methods in ASTM D698 or the procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles. Tests for moisture content and compaction will be taken at a minimum of 1,000 square yards of subgrade. All quality assurance testing shall be done by the Contractor's laboratory in the presence of the DEN PM, and density test results shall be furnished upon completion to the DEN PM for acceptance determination.

The in-place field density shall be determined in accordance with ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content, unless otherwise specified.

If the specified density is not attained, the entire lot shall be re-worked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the DEN PM and the finished subgrade shall be maintained.

**152-2.12 Excavation for Structures.** Excavate to indicated elevations and dimensions within a tolerance of plus-or-minus 1-inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services, other construction, and for inspections.

- a. Excavations for Footings and Foundations.** Do not disturb bottom of excavation. Excavate by hand to final grade, just prior to placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- b. Pile Foundations.** Stop excavations 6-to-12 inches above bottom of pile cap, before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
- c. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures.** Excavate to elevations and dimensions indicated, within a tolerance of plus or minus 1-inch. Do not disturb bottom of excavations intended as bearing surfaces.

**152-2.13 Excavation for Utility Trenches.** Contactor shall adhere to the following provisions when completing utility trench excavations.

- a.** Excavate trenches to indicated gradients, lines, depths, and elevations. Beyond building perimeters, excavate trenches to allow installation of top of pipe below frost line (36-inches below finish grade).
- b.** Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12-inches higher than top

of pipe or conduit, unless otherwise indicated. Clearance: 12-inches each side of pipe or conduit, or as indicated.

- c. Trench Bottoms.** Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
- 1) For pipes and conduit less than 6-inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - 2) For pipes and conduit 6-inches or larger in nominal diameter, shape bottom of trench to support bottom 90-degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
  - 3) For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
  - 4) Excavate trenches 6-inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
  - 5) Excavate trenches 4-inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Excavate trenches 6-inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

**152-2.14 Backfill.** Place and compact backfill in excavations promptly, but not before completing the following:

- a. Construction below finish grade including, where applicable, sub-drainage, damp-proofing, waterproofing, and perimeter insulation
- b. Surveying locations of underground utilities for Record Documents.
- c. Testing and inspecting of underground utilities.
- d. Removal of concrete formwork.
- e. Removal of trash and debris.
- f. Removal of temporary shoring, bracing, and sheeting.
- g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- h. Place backfill on subgrades free of mud, frost, snow, or ice.

**152-2.15 Utility Trench Backfill.** Place and compact backfill in utility trench excavations, in accordance with the following provisions:

- a. Place backfill on subgrades free of mud, frost, snow, or ice.
- b. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- c. **Trenches under Footings.** Backfill trenches excavated under footings and within 18-inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Item P-610.
- d. **Trenches under Roadways.** Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30-inches below surface of roadways. After installing and testing,

completely encase piping or conduit in a minimum of 4-inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Item P-610.

e. Backfill voids with satisfactory soil, while removing shoring and bracing.

**f. Initial Backfill:**

- 1) Soil Backfill: Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1-inch in any dimension, to a height of 12-inches over the pipe or conduit. Carefully compact initial backfill under pipe haunches, and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- 2) Controlled Low-Strength Material: Place initial backfill of P-153 controlled low-strength material to a height of 12-inches over the pipe or conduit. Coordinate backfilling with utilities testing.

**g. Final Backfill:**

- 1) Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- 2) Controlled Low-Strength Material: Place final backfill of P-153 controlled low-strength material to final subgrade elevation.

h. Coordinate backfilling with utilities testing.

i. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

j. Warning Tape: Install warning tape directly above utilities, 12-inches below finished grade, except 6-inches below subgrade under pavements and slabs.

**152-2.16 Finishing and Protection of Subgrade.** Finishing and protection of the subgrade is incidental to the work. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes, or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade, until the subgrade has been accepted by the DEN PM.

**152-2.17 Haul.** All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift, or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining, and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be

made for any work or materials associated with providing, maintaining, and removing haul roads or routes.

**152-2.18 Surface Tolerances.** In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 6-inches, reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the DEN PM. The Contractor shall perform all final smoothness and grade checks in the presence of the DEN PM. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

- a. **Smoothness.** The finished surface shall not vary more than +/- ½ inch, when tested with a 12-foot straight-edge applied parallel with and at right angles to the centerline. The straight-edge shall be moved continuously forward at half the length of the 12-foot straight-edge for the full length of each line on a 50-foot grid.
- b. **Grade.** The grade and crown shall be measured on a 50-foot grid and shall be within +/- 0.05 feet of the specified grade.

On safety areas, turfed areas, and other designated areas within the grading limits where no subbase or base is to be placed, grade shall not vary more than 0.10 feet from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding, or removing materials, and reshaping.

**152-2.19 Topsoil.** When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the DEN PM, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

**152-2.20 Restoring Borrow Areas.** The Contractor shall, upon completion of his borrow excavation activities, prepare the borrow site(s) for topsoiling and seeding by performing the following work:

- a. Remove and bury all rock over 6-inches in dimension in accordance with rock disposal methods, as noted under Section 2.5.
- b. Grade all sites to drain, as indicated in these specifications and the drawings.
- c. Remove all trash and other foreign objects, so that the areas can be re-used for farming purposes.
- d. Rip the borrow area site in a manner as approved by the DEN PM. After the area is ripped to the required 18-inch depth, the ripped area shall be treated on the surface to reduce excessive surface roughness or cloddiness and produce an area suitable for future seeding. Treatment may include discing, harrowing, culti-packing or other means as approved by the DEN PM. In areas where rock is the predominant surface remaining, the Contractor may

spread 18-inches of acceptable material over the rock areas, as approved by the DEN PM, at no additional cost to the Owner.

Disturbed areas shall be reclaimed in accordance with the provisions of Section 015719.

All work required to prepare the borrow area for top-soiling and seeding, as designated under this section, shall be considered as incidental work.

### **METHOD OF MEASUREMENT**

**152-3.1** Measurement for payment specified by the cubic yard shall be computed by the comparison of digital terrain model (DTM) surfaces for computation of neat line design quantities. The end area is that bound by the original ground line established by field cross-sections and the final theoretical pay line established by cross-sections shown on the plans, subject to verification by the DEN PM.

Measurement for payment specified by the square yard shall be measured in-place for the area completed and accepted by the DEN PM.

**152-3.2** The quantity of **Unclassified Excavation – Embank On-Site** to be paid for shall be the number of cubic yards measured in its original position, and utilized as on-site embankment material. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed. **152-3.3** The quantity of **Unclassified Excavation – Export to Waste Area** to be paid for shall be the number of cubic yards measured in its original position and hauled for offsite disposal. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.4** The quantity of **Lower Select Embankment** to be paid for shall be the number of cubic yards measured in its original position, sourced from offsite borrow sources on Airport property, and utilized as on-site embankment material. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.5** The quantity of **Upper Select Embankment** to be paid for shall be the number of cubic yards measured in its original position, sourced from offsite borrow sources on Airport property, and utilized as on-site embankment material. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.6** The quantity of **Subgrade Remediation** to be paid for shall be the number of square yards measured in its original position, accepted in place.

### **BASIS OF PAYMENT**

**152-4.1 Unclassified Excavation – Embank On-Site** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.2 Unclassified Excavation – Export to Waste Area** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.3 Lower Select Embankment** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.4 Upper Select Embankment** payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.5 Subgrade Remediation** shall be made at the contract unit price per square yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-152-4.1	Subgrade Remediation – per square yard
Item P-152-4.2	Unclassified Excavation (Embank On-Site) - per cubic yard
Item P-152-4.3	Unclassified Excavation (Export to Waste Area) – per cubic yard
Item P-152-4.4	Lower Select Embankment – per cubic yard
Item P-152-4.5	Upper Select Embankment – per cubic yard

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

### American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

### ASTM International (ASTM)

ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))

ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2700 kN-m/m<sup>3</sup>))

ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

### Advisory Circulars (AC)

AC 150/5370-2 Operational Safety on Airports During Construction Software

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**Software**

FAARFIELD            FAA Rigid and Flexible Iterative Elastic Layered Design

**U.S. Department of Transportation**

FAA RD-76-66            Design and Construction of Airport Pavements on Expansive Soils

**END OF ITEM P-152**

## Item P-153 Controlled Low-Strength Material (CLSM)

### DESCRIPTION

**153-1.1** This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the Resident Project Representative (RPR).

### MATERIALS

#### 153-2.1 Materials.

**a. Cement.** Cement shall conform to the requirements of ASTM C150 Type I, II, or V, or ASTM C595 Type IL, IS, IP, IT.

**b. Fly ash.** Fly ash shall conform to ASTM C618, Class C or F.

**c. Fine aggregate (sand).** Fine aggregate shall conform to the requirements of ASTM C33 except for aggregate gradation. Any aggregate gradation which produces the specified performance characteristics of the CLSM and meets the following requirements, will be accepted.

Sieve Size	Percent Passing by weight
3/4 inch (19.0 mm)	100
No. 200 (75 µm)	0 - 12

**d. Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**e.** The CLSM used in the construction of Item L-110, Duct Banks, shall have Red Color dye added.

### MIX DESIGN

**153-3.1 Proportions.** The Contractor shall submit, to the RPR, a mix design including the proportions and source of aggregate, fly ash, cement, water, and approved admixtures. No CLSM mixture shall be produced for payment until the RPR has given written approval of the proportions. The proportions shall be prepared by a laboratory and shall remain in effect for the duration of the project. The proportions shall establish a single percentage or weight for aggregate, fly ash, cement, water, and any admixtures proposed. Laboratory costs are incidental to this item.

**a. Compressive strength.** CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 1379 kPa) when tested in accordance with ASTM D4832, with no significant strength gain after 28 days.

**b. Consistency.** Design CLSM to achieve a consistency that will produce an approximate 8-inch (200 mm) diameter circular-type spread without segregation. CLSM consistency shall be determined per ASTM D6103.

## **CONSTRUCTION METHODS**

### **153-4.1 Placement.**

**a. Placement.** CLSM may be placed by any reasonable means from the mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed so structures or pipes are not displaced from their final position and intrusion of CLSM into unwanted areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed by the RPR. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one lift, the base lift shall be free of surface water and loose foreign material prior to placement of the next lift.

**b. Contractor Quality Control.** The Contractor shall collect all batch tickets to verify the CLSM delivered to the project conforms to the mix design. The Contractor shall verify daily that the CLSM is consistent with 153-3.1a and 153-3.1b. Adjustments shall be made as necessary to the proportions and materials as needed. The Contractor shall provide all batch tickets to the RPR.

**c. Limitations of placement.** CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air or ground temperature is at least 35°F (2°C) and rising. Mixing and placement shall stop when the air temperature is 40°F (4°C) and falling or when the anticipated air or ground temperature will be 35°F (2°C) or less in the 24-hour period following proposed placement. At the time of placement, CLSM shall have a temperature of at least 40°F (4°C).

### **153-4.2 Curing and protection**

**a. Curing.** The air in contact with the CLSM shall be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32°F (0°C), the material may be rejected by the RPR if damage to the material is observed.

**b. Protection.** The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the RPR that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 153-3.1a.

**153-4.3 Quality Assurance (QA) Acceptance.** CLSM QA acceptance shall be based upon batch tickets provided by the Contractor to the RPR to confirm that the delivered material conforms to the mix design.

## **METHOD OF MEASUREMENT**

### **153-5.1 Measurement.**

Controlled low-strength material (CLSM) shall be measured by the number of linear feet of existing waterline pipe encasement, as shown on the plans, completed, and accepted. All other CLSM shall not be measured, but shall be considered incidental to the installation of the new utility items.

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### BASIS OF PAYMENT

#### 153-6.1 Payment.

Controlled low-strength material (CLSM) shall be paid for at the contract unit price per linear feet of existing waterline pipe encasement. Payment shall be full compensation for all materials, equipment, labor, and incidentals required to complete the work as specified.

Payment will be made under:

Item P-153-6.1      Waterline Pipe Encasement (CLSM) per linear foot.

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low-Strength Material (CLSM) Test Cylinders
ASTM D6103	Flow Consistency of Controlled Low Strength Material (CLSM)

**END OF ITEM P-153**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-153 CONTROLLED LOW-STRENGTH  
MATERIAL (CLSM)**

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## ITEM P-159 CONCRETE AND ASPHALT CRUSHING

### DESCRIPTION

**159-2.1** This item shall consist of providing all equipment, labor, and utilities necessary to crush and stockpile concrete and asphalt rubble removed from the project and hauled to the North Airfield Recycle Yard, as shown on the project drawings. The following recycled materials will be produced by this contract:

- a. CDOT, Class 6 Aggregate Base Course
- b. Additional size and quantity of material as directed by the DEN Project Manager or DEN Quality Assurance Recycling Yard Inspector.

### 159-2.2 RELATED SECTIONS AND DOCUMENTS.

Section 014510 – Contractor Quality Control

Section 014525 – Material Testing Agency

DEN Concrete and Asphalt Recycle Yards Standard Operating Procedures, (SOP); latest revision dated May 14, 2018

### 159-2.3 SUBMITTALS. (REFER TO SECTION 013300)

Gradation Test Reports

### PRODUCTS

**159-2.1 CLASS 6, CRUSHED AGGREGATE MATERIALS.** Aggregate base shall be material that has been crushed and screened to meet the gradation for CDOT, Class 6 material, as follows:

Sieve Size	% By Weight Passing Square Mesh Sieves
1 inch	100
$\frac{3}{4}$ inch	95-100
No. 4	30-65
No. 8	25-55
No. 200	3-12

Due to the quantity of fine material resulting from crushing concrete, the No. 200 material will be acceptable up to a maximum of 18%.

## EXECUTION

**159-3.1 STOCKPILING.** Removed materials shall be hauled to, crushed and stockpiled at the North Airfield Recycle Yard, as directed by the DEN Quality Assurance Recycling Yard Inspector. Stockpiles of differing materials (asphalt or concrete) shall be placed in locations on the site such that the separate materials will be readily accessible, as directed by the DEN Quality Assurance Recycling Yard Inspector. Separate differing materials with dividers or stockpile apart to prevent mixing. Direct surface water away from stockpile site so as to prevent erosion or deterioration of materials. Stockpile materials with stacking conveyors so as to minimize the footprint of each stockpile. The contractor will supply a conveyor at the discharge from the crusher that is equipped with a calibrated weight scale.

Ensure that all concrete reinforcing, dowel bars, joint sealant, fiber board, and electrical equipment of any nature are segregated from all stockpiles for disposal. All reinforcing metal, or any nature removed from the concrete rubble during crushing operations shall be separated from finished materials for later disposal or recycling by the contractor.

**159-3.2 SITE CLEAN UP.** At the completion of crushing and screening operations, grade site surface to prevent freestanding surface water. Remove all steel reinforcing from the site and dispose of it at either a steel recycling facility or at a state permitted landfill. Remove, and dispose offsite of any excess minus 200 sieve material which may have been generated by the crushing and screening work. Remove any materials used for environmental protection, except that silt fences down grade from stockpiles shall be left in place.

**159-3.3 TESTING.** Class 6 aggregate base course, either concrete or asphalt, will be tested by an independent testing agency following the first 1,000 tons of each material produced. A sieve analysis shall be performed by the Contractor's Independent Testing Agency, and results forwarded to the DEN Project Manager for approval. Following initial approval, additional sieve analyses shall be performed for each additional 5,000 tons of material produced. Reports of each test shall be forwarded to the DEN Project Manager.

## METHOD OF MEASUREMENT

**159-4.1 MEASUREMENT.** Measurement for work shall be the number of tons using the scale at the recycle yard.

## METHOD OF PAYMENT

**159-5.1 PAYMENT.** Payment will be made at the contract unit price per ton for concrete and cement treated base course crushing. This price shall be full compensation for all furnishing all materials, all preparation and placing the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item. The quantity produced of each type of material will be directed by the DEN PM or DEN Quality Assurance Recycling Yard Inspector.

Payment will be made under:

P-159-5.1 Crush PCCP Removals (Class 6) – per ton

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ITEM P-159 CONCRETE AND ASPHALT CRUSHING**

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P-159-5.2 Crush CTB Removals (Class 6) – per ton

**TESTING REQUIREMENTS**

ASTM D75	Practice for Sampling Aggregates
ASTM C117	Materials Finer than 75um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C702	Practice for Reducing Samples of Aggregates to Testing Size

**END OF ITEM P-159**

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## ITEM P-160 WATERING

### DESCRIPTION

**160-1.1** This work shall consist of obtaining, conveying, and applying water for compaction of embankments and subgrades; for concrete; haul road; for dust control; and for any other purposes in accordance with the requirements of the Contract Documents or as designated by the DEN Project Manager (DEN PM).

### MATERIALS

**160-2.1 WATER QUALITY.** Water required for construction use shall be clean and free from sewage, oil, acid, strong alkalis, organic material, and other substances injurious to the finished product. Water obtained from the City supplied source is acceptable for use as construction water. If the Contractor provides an alternative source for water supply, water of questionable quality shall be tested in accordance with ASTM C1602. All alternative supply sources shall be subject to approval by the DEN PM.

**160-2.2 CITY SUPPLIED WATER SOURCE.** The City shall make available a source of construction water from the water line close to the existing Contractor Staging Area location shown on the Drawings. There is not an unlimited supply of water available and the Contractor will be held responsible for misuse of water. The tap size shall be limited to 1-1/2 inches (38 mm).

It shall be the Contractor's responsibility to contact the Denver Water Department (DWD) and the DEN PM and arrange for connection to the above referenced waterline, to include installation of meter. The Contractor's connection plan, its distribution system, and its filling operations must be coordinated with, submitted to, and approved by the DWD prior to installation. All costs associated with waterline connections and distribution shall be included in the unit prices bid for the applicable items of construction.

**160-2.3 POTABLE WATER.** Potable water may be hauled in and stored by the Contractor.

### CONSTRUCTION METHODS

**160-3.1 TRANSPORT OF WATER.** The Contractor may transport water overland to an approved temporary storage facility, or construct temporary supply piping to his primary use point. The approximate location and alignment of the Contractor's temporary supply/distribution system must be approved by the DEN PM in writing prior to its installation and must be removed by the Contractor upon completion of work. Potential contamination of existing domestic water system shall be held as the responsibility of the contractor.

**160-3.2 EQUIPMENT.** The water equipment shall be of capacity and designed to assure uniform application of water in the amounts required.

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TECHNICAL SPECIFICATIONS  
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ITEM P-160 WATERING

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**160-3.3 PERMITS.** The Contractor shall obtain the required DWD permit(s) relative to tapping the water line and/or the use of said water.

**METHOD OF MEASUREMENT**

**160-4.1** There shall be no direct measurement or payment for watering. The work under this item shall be considered subsidiary to other items of work.

**BASIS OF PAYMENT**

**160-5.1** Watering shall be considered incidental to the project. No payment shall be made for watering.

**TESTING REQUIREMENTS**

ASTM C1602            Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

**END OF ITEM P-160**

## Item P-220 Cement Treated Soil Base Course

### DESCRIPTION

**220-1.1** This item shall consist of constructing a base course by uniformly mixing soil, cement, and water. The mixed material shall be spread, shaped, and compacted in accordance with these specifications and in conformity to the dimensions and typical cross-section shown on the plans. Tests shall be required for each approved soil included within the treated layer.

Runway, taxiway, or apron pavements shall be built in a series of parallel lanes using a plan that reduces the number of longitudinal and transverse joints to a minimum.

### MATERIALS

**220-2.1 Cement.** Cement shall conform to the requirements of ASTM C150 Type V. Type I/II LA cement may be substituted for Type V cement, subject to DEN PM approval, should the Type I/II LA cement meet Type V requirements for sulfate resistance, deleterious activity, and total alkali content.

**220-2.2 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**220-2.3 Soil.** The soil for this work shall consist of the uppermost 12 inches of select embankment as placed and paid for by Specifications Item P-152, Upper Select Embankment.

**220-2.4 Asphalt material.** The types, grades, controlling specifications, and application temperatures for the asphalt materials used for curing the soil-cement shall be selected from the table below. The DEN PM will approve the specific material used.

#### Bituminous Materials

Type and Grade	Specification	Application Temperature	
		Degrees F	Degrees C
<b>Cutback Asphalt</b>			
RC-70	ASTM D2028	120-160	50-70
RC-250	ASTM D2028	160-200	70-95
<b>Emulsified Asphalt</b>			
RS-1, SS-1	ASTM D977	75-130	25-55
CRS-1	ASTM D2397	75-130	25-55

## MIX DESIGN

**220-3.1 Proportions.** Before the start of base course construction, tests shall be made on the soil or soil-aggregate material to be stabilized to determine the quantity of cement required for the mix design.

Test specimens containing various amounts of cement shall be compacted per ASTM D558, and the optimum moisture determined for each test specimen. Samples at the optimum moisture shall be subjected to the wet-dry and the freeze-thaw test in accordance with ASTM D559 and ASTM D560, respectively.

The specimens shall be tested for compressive strength in accordance with ASTM D1633. Tests are required for each approved soil which will be included in the treated layer

## CONSTRUCTION METHODS

**220-4.1 Control Strip.** The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the DEN Project Manager (DEN PM), that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The DEN PM must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted or removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the DEN PM. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved by the DEN PM.

**220-4.2 Weather limitations.** The material shall not be mixed or placed while the atmospheric temperature is below 40°F (4°C) or when conditions indicate that the temperature may fall below 40°F (4°C) within 24 hours, or when the weather is foggy or rainy, or to soils that are frozen or contain frost, or when the underlying material is frozen.

**220-4.3 Maintenance.** The material shall be maintained in a condition that will meet all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at their expense.

**220-4.4 Equipment.** The course may be constructed with any equipment that will meet the requirements for soil pulverization, cement application, mixing, water application, incorporation of materials, compaction, finishing, and curing specified here.

**220-4.5 Preparation.** The area to be stabilized shall be graded and shaped to conform to the lines, grades and cross-section shown on the plans. Any soft or yielding areas in the subgrade shall be removed and replaced with acceptable soil and compacted to the specified density.

**220-4.6 Pulverization.** After completion of moist-mixing, the soil for the base course shall be pulverized so that 100% by dry weight passes a 1-inch (25.0 mm) sieve and a minimum of 80% passes a No. 4 (4.75 mm) sieve.

**220-4.7 Cement application, mixing, and finishing.** Mixing of the soil, cement, and water shall be accomplished by one of the following methods to be approved by the DEN PM.

**a. Mix in Place Method.** Shape pulverized material to the cross-section indicated. Cement shall be applied so that when uniformly mixed with the soil, the specified cement content is obtained, and a sufficient quantity of cement-treated soil is produced to construct a compacted cement-treated course conforming to the lines, grades, and cross-section indicated. Immediately after the cement has been distributed, it shall be mixed with the soil. The cement shall not be mixed below the required depth. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Determine moisture content of the mixture immediately after completion of mixing of the soil and cement. Provide water supply and pressure distributing equipment that will permit the application within three (3) hours of all mixing water on the section being processed. Incorporate water in the mix so that concentration of water near the surface does not occur. After all mixing water has been applied, continue mixing until the water is uniformly distributed throughout the full depth of the mixture. Do not apply cement if the soil moisture content exceeds the optimum moisture content specified for the cement-treated mixture. After mixing is complete, the proportions of the mixture shall be in accordance with the approved mix design.

**b. Central Plant Mix Method.** Cement application, mixing, and spreading. Mixing of the soil, cement, and water shall be accomplished by the central-plant-mixed method. The soil, cement, and water shall be mixed in either a batch or continuous-flow type pugmill. The plant shall be equipped with feeding and metering devices that will add the soil, cement, and water into the mixer in the specified quantities. Soil and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform mixture of soil, cement, and water is obtained.

The mixture shall be hauled to the project in trucks equipped with protective covers. The mixture shall be placed on the moistened subgrade in a uniform layer by an approved spreader. Not more than 30 minutes shall elapse between the placement of soil-cement in adjacent lanes.

The layer of soil-cement shall be uniform in thickness and surface contour and of sufficient quantity that the completed base conforms to the required line, grade and cross-section. Dumping of the mixture in piles or windrows on the subgrade shall not be permitted.

Not more than 60 minutes shall elapse between the start of moist mixing and the start of compaction of soil-cement

**220-4.8 Compaction.** Compaction of the course shall begin within 30 minutes after mixing the cement into the subgrade. All compaction operations shall be completed within 2 hours from the start of mixing.

The field density of the compacted mixture shall be at least 98% of the maximum density as determined by ASTM D558. The in-place moisture content shall be determined in accordance with ASTM D2216. The moisture content of the mixture at the start of compaction shall be within  $\pm 2$  percentage points of the optimum moisture content. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**220-4.9 Finishing and curing.** After the final lift or course of treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

Finished portions of treated subgrade shall be protected to prevent equipment from marring, permanently deforming, or damaging completed work.

Not later than 24 hours after completion of final finishing, the surface shall be cured by application of an emulsified asphalt uniformly applied to the surface of the completed base course at the rate of approximately 0.2 gallons per square yard (0.91 l/m<sup>2</sup>). The curing material shall be maintained and applied as needed by the Contractor during the 7-day protection period.

Sufficient protection from freezing shall be provided for at least 7 days after its construction or as approved by the DEN PM.

**220-4.10 Construction limitations.** At the end of each day's construction and/or when operations after application of the cement are interrupted for more than 30 minutes, a straight transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true vertical face.

Completed portions may be opened to light traffic, if approved by the DEN PM, and provided the curing is not impaired.

**220-4.11 Surface tolerance.** In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the DEN PM. The Contractor shall perform all final smoothness and grade checks in the presence of the DEN PM. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

**a. Smoothness.** The finished surface shall not vary more than +/- 3/8 inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/-0.05 feet (15 mm) of the specified grade.

**220-4.12 Acceptance sampling and testing.** Cement Treated Solid Base course shall be accepted for density and thickness on an area basis. Two test will be made for density and thickness for each 1,200 square yards (1000 square meters), but not less than four (4) tests per day of production. Sampling locations will be determined on a random basis per ASTM D3665.

**a. Density.** The DEN PM shall perform all density tests.

Each area shall be accepted for density when the field density is at least 98% of the maximum density of laboratory specimens compacted and tested per ASTM D558. The in-place field density shall be determined per ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The in-place moisture content shall be determined in accordance with ASTM D2216. Perform in-place density test immediately after completion of compaction to determine degree of compaction. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified. If the specified density is not attained, the area represented by the failed test must be reworked and/or recompacted at the Contractor's expense and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**b. Thickness.** Depth tests shall be made by test holes or cores at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the

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Contractor in the presence of the DEN PM for each subplot. Where the thickness is deficient by more than 1/2-inch (12 mm), the material shall be removed to full depth and replaced, at Contractor's expense.

### **METHOD OF MEASUREMENT**

**220-5.1** The quantity of cement treated soil base course shall be the number of square yards (square meter) of completed and accepted base course.

**220-5.2** Cement shall be measured by the ton (kg).

### **BASIS OF PAYMENT**

**220-6.1** Payment shall be made at the contract unit price per square yard (m<sup>2</sup>) for cement treated soil base course. This price shall be full compensation for furnishing all materials, except cement, and for all preparation, delivering, placing, and mixing of these materials; and for all labor, equipment, tools and incidentals necessary to complete the item.

**220-6.2** Payment shall be made at the contract unit price per ton (kg) for cement. This price shall be full compensation for furnishing this material and for all delivery, placing, and incorporation of this material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-220-6.1	Cement Treated Soil Base Course (12-Inch) - per square yard
Item P-220-6.2	Cement Treated Soil Base Course (8-Inch) - per square yard
Item P-220-6.3	Cement - per ton

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C1632	Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory <sup>1</sup>
ASTM C1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D558	Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-220 CEMENT TREATED SOIL BASED COURSE****DENVER INTERNATIONAL AIRPORT**  
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ASTM D559	Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D560	Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil In-Place by the Sand Cone Method
ASTM D2027	Standard Specification for Cutback Asphalt (Medium-Curing Type)
ASTM D2028	Standard Specification for Cutback Asphalt (Rapid-Curing Type)
ASTM D2397	Standard Specification for Cationic Emulsified Asphalt
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**END OF ITEM P-220**

## Item P-304 Cement-Treated Aggregate Base Course (CTB)

### DESCRIPTION

**304-1.1** This item shall consist of a cement-treated base (CTB) course composed of mineral aggregate and cement, uniformly blended and mixed with water. The mixed material shall be spread and shaped with a mechanical spreader, and compacted with rollers in accordance with these specifications and in conformance to the lines, grades, dimensions, and cross-sections shown on the plans.

### MATERIALS

**304-2.1 Aggregate.** The aggregate shall be select granular materials, comprised of crushed or uncrushed gravel and/or stone, or recycled cement concrete. The material shall be free of roots, sod, and weeds. The crushed or uncrushed aggregate shall consist of hard, durable particles meeting the requirements in the table below.

#### Cement Treated Aggregate Base Material Requirements

Material Test	Requirement	Standard
<b>Coarse Aggregate Portion (retained on the No. 4 (4.75 mm) sieve)</b>		
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Flat Particles, Elongated Particles, or Flat and Elongated Particles <sup>1</sup>	10% maximum, by weight, for fraction retained on the ½ inch (12.5mm) sieve and 10% maximum, by weight, for the fraction passing the 1/2-inch (12.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
<b>Fine Aggregate Portion (Passing the No. 40 (425µm) sieve)</b>		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index	Not more than 6	ASTM D4318

<sup>1</sup> A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

**304-2.2 Gradation Requirements.** The aggregate shall conform to the gradation(s) shown in the table below per ASTM C136, A dense, well-graded aggregate blend that meets the requirements of the table shall be selected by the Contractor and used in the final mix design. The final aggregate blend shall be well graded from coarse to fine within the limits designated in

the table and shall not vary from the low limit on one sieve to the high limit on adjacent sieves, or vice versa.

### Aggregate Gradation for CTB Material

Sieve Size	Design Range Percentage by Weight Passing	Contractor's Final Gradation	Job Control Grading Band Tolerances for Contractor's Final Gradation <sup>2</sup> Percent
2 inch (50 mm)	100		±0
1 inch (25.0 mm)	90-100		±5
No. 4 (4.75 mm)	45-95		±8
No. 10 (2.00 mm)	37-80		±8
No. 40 (425 µm)	15-50		±5
No. 200 (75 µm)	0–15		±3

For Contractor quality control, sample the aggregate stockpile in accordance with ASTM D75 and perform gradation tests in accordance with ASTM C136 a minimum of once per week during production of CTB.

#### 304-2.3 Sampling and testing.

**a. Aggregate base materials.** The Contractor shall take samples of the aggregate base stockpile in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraphs 304-2.1 and 304-2.2. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

**304-2.4 Cement.** Cement shall conform to the requirements of ASTM C150, Type I or II, or ASTM C595 Type IP or IL.

**304-2.5 Cementitious additives.** Pozzolanic and slag cement may be added to the CTB mix. If used, each material must meet the following requirements:

**a. Pozzolan.** Pozzolanic materials must meet the requirements of ASTM C618, Class F, or N with the exception of loss of ignition, where the maximum shall be less than 6%.

**b. Slag cement (ground granulated blast furnace (GGBF) slag).** Slag shall conform to ASTM C989, Grade 100, or 120.

**304-2.6 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**304-2.7 Curing materials.** Curing material shall be a white-pigmented, liquid membrane-forming compound conforming to ASTM C309, Type 2, Class A or Class B (wax-based).

### COMPOSITION OF MIXTURE

**304-3.1 General.** The CTB material shall be composed of a mixture of aggregate, cementitious material, and water. Fly ash or slag cement may be used as a partial replacement for cement.

**304-3.2 Mix design.** The mix design shall use a cement content that, when tested in the laboratory per ASTM D1633, produces a 7-day compressive strength between 300 pounds per square inch (2068 kPa) minimum and 600 pounds per square inch (3447 kPa) maximum. Avoid higher strengths due to potential to cause shrinkage and reflective cracks.

Wet-dry and/or freeze-thaw tests shall be performed in accordance with ASTM D559 and ASTM D560 respectively. The weight loss for each type of test shall not exceed 14% after 12 cycles.

The mix design shall include a complete list of materials, including type, brand, source, and amount of cement, fine aggregate, coarse aggregate, water, and cementitious additives.

Should a change be made in aggregate sources or type of cement, or if cementitious additives are added or deleted from the mix, production of the CTB mix shall be stopped and a new mix design shall be submitted.

**304-3.3 Submittals.** At least 30 days prior to the placement of the CTB, the Contractor shall submit certified test reports to the DEN Project Manager (DEN PM) for those materials proposed for use during construction, as well as the mix design information for the CTB material. Tests older than six (6) months shall not be used. The certification shall show the ASTM or AASHTO specifications or tests for the material, the name of the company performing the tests, the date of the tests, the test results, and a statement that the material did or did not comply with the applicable specifications. The submittal package shall include the following:

- a. Source(s) of materials, including aggregate, cement, cementitious additives, curing, and bond-breaking materials.
- b. Physical properties of the aggregates, cement, cementitious additives, curing, and bond-breaking materials.
- c. Mix design:
  - Mix identification number
  - Aggregate gradation
  - Cement content
  - Water content
  - Cementitious materials content
  - Compaction and strength results
  - Laboratory compaction characteristics (maximum dry density and optimum moisture content)
  - Compressive strength at seven (7) days
  - Wet-dry and/or freeze-thaw weight loss

No CTB material shall be placed until the submittal is accepted in writing by the DEN PM.

During production, the Contractor shall submit batch tickets for each delivered load.

## **EQUIPMENT**

**304-4.1 Mixing.** The mixer shall be a batch or continuous-flow type stationary mixer that produces a well-blended, uniform mixture of aggregate, cement, water, and pozzolan. The mixer shall be equipped with calibrated metering and feeding devices that introduce the aggregate, cement, water, and cementitious additives (if used) into the mixer in the specified quantities.

The DEN PM shall have free access to the plant at all times for inspection of the plant's equipment and operation and for sampling the CTB mixture.

**304-4.2 Hauling.** The CTB material shall be transported from the plant to the job site in trucks or other hauling equipment having beds that are smooth, clean, and tight. Truck bed covers shall be provided and used to protect the CTB from weather. CTB material that becomes wet during transport shall be rejected.

**304-4.3 Placing.** CTB material shall be placed with a mechanical spreader capable of receiving, spreading, and shaping the mixture without segregation into a uniform layer or lift. The equipment shall be equipped with a strike-off plate and end gates capable of being adjusted to the layer thickness and width.

**304-4.4 Compaction.** The number, type, and weight of rollers and/or compactors shall be sufficient to compact the mixture to the required density.

## **CONSTRUCTION METHODS**

**304-5.1 Control Strip.** The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the DEN PM, that the materials, equipment, and construction processes meet the requirements of the specification. Control strips that do not meet specification requirements shall be removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the DEN PM. Upon acceptance of the control strip by the DEN PM, the Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the DEN PM.

**304-5.2 Weather limitations.** The CTB shall not be placed on frozen surfaces or when weather conditions will detrimentally affect quality of the finished course. Apply cement when the ambient temperature is a minimum of 40°F (4°C) and rising and aggregate are not frozen or contain frost. If ambient temperature falls below 40°F (4°C), protect completed CTB areas against freezing.

The Contractor should stop operations prior to and during rain allowing time to cover and protect any freshly placed material. Areas damaged by rain shall be replaced at the Contractor's expense.

**304-5.3 Maintenance.** Completed portions of the cement-stabilized area may be opened to local traffic provided the curing process is not impaired and to other traffic after the curing period has elapsed, provided that the cement-stabilized course has hardened sufficiently to prevent surface marring or distortion by equipment or traffic. Protect finished portions of cement stabilized base from traffic of equipment used in constructing adjoining sections in a manner to prevent marring or damaging completed work. The CTB shall be protected from freezing until covered.

**304-5.4 Preparation of underlying course.** The underlying course shall be checked by the DEN PM before placing and spreading operations are started. Prior to placing the material, the final grade should be firm, moist and free of frost. Use of chemicals to eliminate frost will not be permitted. The underlying course shall be wetted in advance of placing the CTB layer.

**304-5.5 Grade control.** Grade control between the edges of the CTB shall be accomplished at intervals of 50 feet (15 m) on the longitudinal grade and at 25 feet (7.5 m) on the transverse grade.

**304-5.6 Placing.** The CTB mixture shall be deposited on the moistened subgrade or subbase and spread into a uniform layer of specified width and thickness that, when compacted and trimmed, conforms to the required line, grade, and cross-section. The longitudinal joints shall be located so there is no offset a 2 foot (600 mm) minimum offset from planned joints in any overlying layer. Placement of the material shall begin along the centerline of the pavement on a crowned section or on the highest elevation contour of a pavement with variable cross slope.

The Contractor shall install the CTB layer in single compacted layer no greater than 6 inches (150 mm) thick.

**304-5.7 Compaction.** All compaction operations shall be completed within 2 hours from the start of mixing. The field density of the compacted mixture shall be at least 98% of the maximum density in accordance with paragraph 304-6.1a. At the start of compaction, the moisture content shall be within  $\pm 2$  percentage points of the specified optimum moisture. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**304-5.8 Finishing.** After compaction, shape the surface of the CTB layer to the specified lines, grades, and cross-section. During the finishing process, the surface shall be kept moist by means of fog-type sprayers. Compaction and finishing shall produce a smooth, dense surface, free of ruts, cracks, ridges, and loose material.

**304-5.9 Construction limitations.** All placement, compaction, and finishing operations shall be completed within two (2) hours from the start of mixing. Material not completed within the 2-hour time limit shall be removed and replaced at the Contractor's expense.

At the end of each day's construction and/or when operations are interrupted for more than 30 minutes, a straight transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true vertical face.

Completed portions may be opened to light traffic, if approved by the DEN PM, and provided the curing is not impaired.

**304-5.10 Curing.** The compacted and finished CTB shall be cured with the approved curing agents as soon as possible, but in no case later than two (2) hours after completion of the finishing operations. Curing material(s) shall meet the requirements in paragraph 304-2.7. The layer shall be kept moist using a moisture-retaining cover or a light application of water until the curing material is applied.

The surface of the CTB layer shall be uniformly sprayed with a liquid membrane-forming curing compound at the rate of one gallon (3.8 liters) to not more than 100 square feet (9.3 m<sup>2</sup>) to obtain a uniform cover over the surface. Hand spraying of odd widths or shapes and CTB surfaces exposed by the removal of forms is permitted.

The curing seal shall be maintained and protected until the pavement is placed. If the surface of the finished CTB and/or the curing seal becomes damaged, additional curing material shall be applied at the time it is damaged or when the damage is first observed.

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**304-5.11 Surface tolerance.** The Contractor shall perform smoothness and grade checks in the presence of the DEN PM. Any area not meeting smoothness and grade shall be corrected by the Contractor at the Contractor's expense.

**a. Smoothness.** The finished surface shall not vary more than  $\pm 3/8$ -inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline, and, moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade shall be measured on a 50-foot (15-m) grid and shall be within  $\pm 0.05$  feet (15 mm) of the specified grade.

**304-5.12 Bond-breaker.** No bond breaker is required.

### **MATERIAL ACCEPTANCE**

**304-6.1 Acceptance sampling and testing.** Cement Treated Aggregate base course shall be accepted for density and thickness on an area basis. Two tests shall be made for density and thickness for each 1200 square yards (1000 square meters), but not less than four (4) tests per day of production. Sampling locations will be determined on a random basis per ASTM D3665.

**a. Density testing.** CTB samples representing the material placed shall be taken to establish density and moisture requirements in accordance with ASTM D558. Additional CTB samples will be taken as necessary to verify density and moisture requirements. The DEN PM shall perform all density tests.

Each area shall be accepted for density when the field density is at least 98% of the maximum density of laboratory specimens. The in-place field density shall be determined in accordance with ASTM D1556 or ASTM D6938, Procedure A, direct transmission method. The in-place moisture content shall be determined in accordance with ASTM D2216. Perform in-place density test immediately after completion of compaction to determine degree of compaction. If the material fails to meet the density requirements, compaction shall continue or the material shall be removed and replaced at the Contractor's expense. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**b. Thickness.** The thickness of the CTB shall be determined by survey on a 25-foot (7.5 m) by 25-foot (7.5 m) survey grid.

When the thickness measurement is deficient by more than 1/2 inch (12 mm), the area represented by the tests shall be removed and replaced at the Contractor's expense.

### **METHOD OF MEASUREMENT**

**304-7.1 Cement-treated base course.** The quantity of cement-treated base course will be determined by measurement of the number of square yards ( $m^2$ ) of CTB actually constructed and accepted by the DEN PM as complying with the plans and specifications.

### **BASIS OF PAYMENT**

**304-8.1 Cement-treated base course.** Payment shall be made at the contract unit price per square yard ( $m^2$ ) for cement-treated base course. This price shall be full compensation for furnishing all materials, including cement; for all preparation, manipulation, placing, and curing

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of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-304-8.1      Cement Treated Base Course (8-Inch) – per square yard

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C150	Standard Specification for Portland Cement
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregate
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D558	Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D559	Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D560	Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

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ASTM D1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D2397	Standard Specification for Cationic Emulsified Asphalt
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**END OF ITEM P-304**

## ITEM P-304C CDOT AGGREGATE BASE COURSE (FOR ACCESS ROADS ONLY)

### DESCRIPTION

**304C-1.1** This work consists of furnishing and placing one or more courses of aggregate on a prepared base course.

### MATERIALS

**304C-2.1 AGGREGATE** Aggregates for bases shall be crushed stone, crushed slag, crushed gravel, natural gravel, or crushed reclaimed concrete or asphalt material which conforms to the quality requirements of AASHTO M 147 except that the requirements for the ratio of minus No. 200 sieve fraction to the minus No. 40 sieve fraction, stated in 2.2.2 of AASHTO M 147, shall not apply. Aggregates for bases shall meet the grading requirements of Table 1. The liquid limit shall not be greater than 30 and the plasticity index shall not exceed 6 when the aggregate is tested in accordance with AASHTO T 89 and T 90 respectively.

**TABLE 1**

**CLASSIFICATION FOR AGGREGATE BASE COURSE (CLASS 6)**

Sieve Size	Design Range - Percentage by Weig
1 in	100
3/4 in	95-100
No. 4	30-65
No. 8	25-55
No. 200	3-12

Acceptance will be based on random samples taken from each lift.

**304C-2.2 SEPARATION GEOTEXTILE.** Separation geotextile Class 2;  $0.02 \text{ sec}^{-1}$  permittivity per ASTM D4491; Apparent opening size per ASTM D4751 with 0.60 mm maximum average value.

### CONSTRUCTION METHODS

**304C-3.1 PLACING.** If the required compaction depth of the aggregate base course exceeds 6 inches, it shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

**304C-3.2 MIXING.** The Contractor shall mix the aggregate by methods that insure a thorough and homogeneous mixture.

**304C-3.3 SHAPING AND COMPACTION.** Compaction of each layer shall continue until a density of not less than 95 percent of the maximum density determined in accordance with AASHTO T 180 as modified by CP 23 has been achieved. The moisture content shall be at +/-2 percent of optimum moisture content. The surface of each layer shall be maintained during the compaction operations so that a uniform texture is produced and the aggregates are firmly keyed. Moisture conditioning shall be performed uniformly during compaction.

Compaction of each reclaimed asphalt pavement aggregate layer shall continue until a wet density of not less than 95 percent of the maximum wet density when determined in accordance with a one point AASHTO T 180, Method D test has been achieved.

The surface of the base course will be tested with a 12-foot straightedge. The surface shall be tested prior to placement of the pavement. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall not exceed 3/8-inch. All irregularities exceeding the specified tolerance shall be corrected to the satisfaction of the DEN Project Manager at no additional cost to the Owner.

### METHOD OF MEASUREMENT

**304C-4.1** CDOT Aggregate Base Course will be measured by the square yard compacted in place.

**304C-4.2** Separation geotextile shall be measured by the number of square yards of materials placed and accepted by the DEN PM as complying with the plans and specifications excluding seam overlaps and edge anchoring.

### BASIS OF PAYMENT

**304C-5.1** Payment shall be made at the contract unit price per square yard of CDOT aggregate base course. This price shall be full compensation for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item. Water will not be measured and paid for separately but shall be included in the work.

**304C-5.2** Payment shall be made at the contract unit price per square yard for separation geotextile-class 2. The price shall be full compensation for furnishing all labor, equipment, material, anchors, and necessary incidentals.

Payment will be made under:

Item P-304C-5.1	CDOT Aggregate Base Course, Class 6 (6-Inch)– per square yard
Item P-304C-5.2	Separation Geotextile – per square yard

### TESTING REQUIREMENTS

AASHTO T 89	Standard Method Test for Determining the Liquid Limit of Soils
AASHTO T 90	Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils

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**TECHNICAL SPECIFICATIONS**  
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AASHTO T 180      Standard Method of Test for Moisture-Density Relations of Soils

**MATERIAL REQUIREMENTS**

AASHTO M 147      Standard Specification for Materials for Aggregate and Soil-Aggregate  
Subbase, Base and Surface Courses

**END OF ITEM P-304C**

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## Item P-401 Asphalt Mix Pavement

### DESCRIPTION

**401-1.1** This item shall consist of pavement courses composed of mineral aggregate and asphalt binder mixed in a central mixing plant and placed on a prepared base or stabilized course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

### MATERIALS

**401-2.1 Aggregate.** Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand, and mineral filler, as required. The aggregates should have no known history of detrimental pavement staining due to ferrous sulfides, such as pyrite. Coarse aggregate is the material retained on the No. 4 (4.75 mm) sieve. Fine aggregate is the material passing the No. 4 (4.75 mm) sieve.

**a. Coarse aggregate.** Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Coarse aggregate material requirements are given in the table below.

### Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Percentage of Fractured Particles	For pavements designed for aircraft gross weights of 60,000 pounds (27200 kg) or more: Minimum 75% by weight of particles with at least two fractured faces and 85% with at least one fractured face <sup>1</sup>	ASTM D5821
	For pavements designed for aircraft gross weights less than 60,000 pounds (27200 kg): Minimum 50% by weight of particles with at least two fractured faces and 65% with at least one fractured face <sup>1</sup>	
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 <sup>2</sup>	ASTM D4791
Bulk density of slag <sup>3</sup>	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29.

<sup>1</sup> The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

<sup>2</sup> A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

<sup>3</sup> Only required if slag is specified.

**b. Fine aggregate.** Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel and shall be free from coatings of clay, silt, or other objectionable matter. Natural (non-manufactured) sand may be used to obtain the gradation of the fine aggregate blend or to improve the workability of the mix. Fine aggregate material requirements are listed in the table below.

### Fine Aggregate Material Requirements

Material Test	Requirement	Standard
Liquid limit	25 maximum	ASTM D4318
Plasticity Index	4 maximum	ASTM D4318
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Sand equivalent	45 minimum	ASTM D2419

**c. Sampling.** ASTM D75 shall be used in sampling coarse and fine aggregate.

**401-2.2 Mineral filler.** Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler shall meet the requirements of ASTM D242.

### Mineral Filler Requirements

Material Test	Requirement	Standard
Plasticity Index	4 maximum	ASTM D4318

**401-2.3 Asphalt binder.** Asphalt binder shall conform to ASTM D6373 Performance Grade (PG) 64-22.

### Asphalt Binder PG Plus Test Requirements

Material Test	Requirement	Standard
Elastic Recovery	75% minimum	ASTM D6084 <sup>1</sup>

<sup>1</sup> Follow procedure B on RTFO aged binder.

**401-2.4 Anti-stripping agent.** Any anti-stripping agent or additive (anti-strip) shall be heat stable and shall not change the asphalt binder grade beyond specifications. Anti-strip shall be an approved material of the Department of Transportation of the State in which the project is located.

## COMPOSITION

**401-3.1 Composition of mixture(s).** The asphalt mix shall be composed of a mixture of aggregates, filler and anti-strip agent if required, and asphalt binder. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

**401-3.2 Job mix formula (JMF) laboratory.** The laboratory used to develop the JMF shall possess a current certificate of accreditation, listing D3666 from a national accrediting authority and all test methods required for developing the JMF; and be listed on the accrediting authority's website. A copy of the laboratory's current accreditation and accredited test methods

shall be submitted to the Resident Project Representative (DEN PM) prior to start of construction.

**401-3.3 Job mix formula (JMF).** No asphalt mixture shall be placed until an acceptable mix design has been submitted to the DEN PM for review and accepted in writing. The DEN PM's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

When the project requires asphalt mixtures of differing aggregate gradations and/or binders, a separate JMF shall be submitted for each mix. Add anti-stripping agent to meet tensile strength requirements.

The JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 401-3.2. The asphalt mixture shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared and compacted using the gyratory compactor in accordance with ASTM D6925.

Should a change in sources of materials be made, a new JMF must be submitted to the DEN PM for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the DEN PM and a new or modified JMF is required for whatever reason, the subsequent cost of the new or modified JMF, including a new control strip when required by the DEN PM, will be borne by the Contractor.

The DEN PM may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates proposed for project use.

The JMF shall be dated, and stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF in accordance with paragraph 401-2.3. Certificate of asphalt performance grade is with modifier already added, if used and must indicate compliance with ASTM D6373. For plant modified asphalt binder, certified test report indicating grade certification of modified asphalt binder.
- Manufacturer's Certificate of Analysis (COA) for the anti-stripping agent if used in the JMF in accordance with paragraph 401-2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 401-2.1.
- Percent passing each sieve size for individual gradation of each aggregate cold feed and/or hot bin; percent by weight of each cold feed and/or hot bin used; and the total combined gradation in the JMF.
- Specific Gravity and absorption of each coarse and fine aggregate.
- Percent natural sand.
- Percent fractured faces.
- Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).

- Percent of asphalt.
- Number of blows or gyrations
- Laboratory mixing and compaction temperatures.
- Supplier-recommended field mixing and compaction temperatures.
- Plot of the combined gradation on a 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.
- Tensile Strength Ratio (TSR).
- Type and amount of Anti-strip agent when used.
- Asphalt Pavement Analyzer (APA) results.
- Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.

**Table 1. Asphalt Design Criteria**

<b>Test Property</b>	<b>Value</b>	<b>Test Method</b>
Number of blows or gyrations	75	
Air voids (%)	3.5	ASTM D3203
Percent voids in mineral aggregate (VMA), minimum	See Table 2	ASTM D6995
Tensile Strength Ratio (TSR) <sup>1</sup>	not less than 80 at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA) <sup>2,3</sup>	Less than 10 mm @ 4000 passes	AASHTO T340 at 250 psi hose pressure at 64°C test temperature

<sup>1</sup> Test specimens for TSR shall be compacted at  $7 \pm 1.0$  % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

<sup>2</sup> AASHTO T340 at 100 psi hose pressure at 64°C test temperature may be used in the interim. If this method is used the required Value shall be less than 5 mm @ 8000 passes

<sup>3</sup> Where APA not available, use Hamburg Wheel test (AASHTO T-324) 10mm @ 20,000 passes at 50°C.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM C136 and ASTM C117.

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the sources of supply; be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

**Table 2. Aggregate - Asphalt Pavements**

<b>Sieve Size</b>	<b>Percentage by Weight Passing Sieve</b>
1 inch (25.0 mm)	--
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	90-100
3/8 inch (9.5 mm)	72-88
No. 4 (4.75 mm)	53-73
No. 8 (2.36 mm)	38-60
No. 16 (1.18 mm)	26-48
No. 30 (600 µm)	18-38
No. 50 (300 µm)	11-27
No. 100 (150 µm)	6-18
No. 200 (75 µm)	3-6
<b>Minimum Voids in Mineral Aggregate (VMA)<sup>1</sup></b>	15.0
<b>Asphalt Percent:</b>	
Stone or gravel	5.0 – 7.5*
Slag	6.5 – 9.5
<b>Recommended Minimum Construction Lift Thickness</b>	2 inch

<sup>1</sup>To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition.

**Table 2. Aggregate - Asphalt Pavements**

Sieve Size	Percentage by Weight Passing Sieves		
	Gradation 1	Gradation 2	Gradation 3 <sup>1</sup>
1 inch (25.0 mm)	100	--	--
3/4 inch (19.0 mm)	90-100	100	--
1/2 inch (12.5 mm)	68-88	90-100	100
3/8 inch (9.5 mm)	60-82	72-88	90-100
No. 4 (4.75 mm)	45-67	53-73	58-78
No. 8 (2.36 mm)	32-54	38-60	40-60
No. 16 (1.18 mm)	22-44	26-48	28-48
No. 30 (600 µm)	15-35	18-38	18-38
No. 50 (300 µm)	9-25	11-27	11-27
No. 100 (150 µm)	6-18	6-18	6-18
No. 200 (75 µm)	3-6	3-6	3-6
Minimum Voids in Mineral Aggregate (VMA)	14.0	15.0	16.0
<b>Asphalt percent by total weight of mixture:</b>			
Stone or gravel	4.5-7.0	5.0-7.5	5.5-8.0
Slag	5.0-7.5	6.5-9.5	7.0-10.5
Recommended Minimum Construction Lift Thickness	3 inch	2 inch	1 1/2 inch

<sup>1</sup> Gradation 3 is intended for leveling courses. FAA approval is required for use in other locations.

**401-3.4 Reclaimed asphalt pavement (RAP).** RAP shall not be used.

**401-3.5 Control Strip.** Full production shall not begin until an acceptable control strip has been constructed and accepted in writing by the DEN PM. The Contractor shall prepare and place a quantity of asphalt according to the JMF. The underlying grade or pavement structure upon which the control strip is to be constructed shall be the same as the remainder of the course represented by the control strip.

The Contractor will not be allowed to place the control strip until the Contractor quality control program (CQCP), showing conformance with the requirements of paragraph 401-5.1, has been accepted, in writing, by the DEN PM.

The control strip will consist of at least 250 tons (227 metric tons) or 1/2 subplot, whichever is greater. The control strip shall be placed in two lanes of the same width and depth to be used in production with a longitudinal cold joint. The cold joint must be cut back in accordance with paragraph 401-4.14 using the same procedure that will be used during production. The cold joint for the control strip will be an exposed construction joint at least four (4) hours old or when

the mat has cooled to less than 160°F (71°C). The equipment used in construction of the control strip shall be the same type, configuration and weight to be used on the project.

The control strip will be considered acceptable by the DEN PM if the gradation, asphalt content, and VMA are within the action limits specified in paragraph 401-5.5a; and Mat density greater than or equal to 94.5%, air voids 3.5% +/- 1%, and joint density greater than or equal to 92.5%.

If the control strip is unacceptable, necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made and another control strip shall be placed. Unacceptable control strips shall be removed at the Contractor's expense.

The control strip will be considered one lot for payment based upon the average of a minimum of 3 samples (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 401-8.1 using a lot pay factor equal to 100.

## CONSTRUCTION METHODS

**401-4.1 Weather limitations.** The asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the DEN PM, if requested; however, all other requirements including compaction shall be met.

**Table 4. Surface Temperature Limitations of Underlying Course**

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40 <sup>1</sup>	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

**401-4.2 Asphalt plant.** Plants used for the preparation of asphalt shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 including the following items.

**a. Inspection of plant.** The DEN PM, or DEN PM's authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

**b. Storage bins and surge bins.** The asphalt mixture stored in storage and/or surge bins shall meet the same requirements as asphalt mixture loaded directly into trucks. Asphalt mixture shall not be stored in storage and/or surge bins for a period greater than twelve (12) hours. If the DEN PM determines there is an excessive heat loss, segregation, or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

**401-4.3 Aggregate stockpile management.** Aggregate stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the asphalt batch plant.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

**401-4.4 Hauling equipment.** Trucks used for hauling asphalt shall have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the DEN PM. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

**401-4.4.1 Material transfer vehicle (MTV).** Material transfer vehicles used to transfer the material from the hauling equipment to the paver, shall use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation. Material transfer vehicles are not required but may be used.

**401-4.5 Asphalt pavers.** Asphalt pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The asphalt paver shall be equipped with a control system capable of automatically maintaining the specified screed grade and elevation.

If the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued.

The paver shall be capable of paving to a minimum width specified in paragraph 401-4.12.

**401-4.6 Rollers.** The number, type, and weight of rollers shall be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing of the aggregate, depressions or other damage to the pavement surface. Rollers shall be in good condition, clean, and capable of operating at slow speeds to avoid displacement of the asphalt. All rollers shall be specifically designed and suitable for compacting asphalt concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used.

**401-4.7 Density device.** The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall supply a qualified technician during all paving operations to calibrate the gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the DEN PM upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

**401-4.8 Preparation of asphalt binder.** The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. The temperature of unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles,

but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

**401-4.9 Preparation of mineral aggregate.** The aggregate for the asphalt shall be heated and dried. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

**401-4.10 Preparation of Asphalt mixture.** The aggregates and the asphalt binder shall be weighed or metered and mixed in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all asphalt upon discharge shall not exceed 0.5%.

**401-4.11 Application of Prime and Tack Coat.** Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A tack coat shall be applied in accordance with Item P-603 to all vertical and horizontal asphalt and concrete surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

**401-4.12 Laydown plan, transporting, placing, and finishing.** Prior to the placement of the asphalt, the Contractor shall prepare a laydown plan with the sequence of paving lanes and width to minimize the number of cold joints; the location of any temporary ramps; laydown temperature; and estimated time of completion for each portion of the work (milling, paving, rolling, cooling, etc.). The laydown plan and any modifications shall be approved by the DEN PM.

Deliveries shall be scheduled so that placing and compacting of asphalt is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to approximately ambient temperature. The Contractor, at their expense, shall be responsible for repair of any damage to the pavement caused by hauling operations.

Contractor shall survey each lift of asphalt surface course and certify to DEN PM that every lot of each lift meets the grade tolerances of paragraph 401-6.2d before the next lift can be placed.

Edges of existing asphalt pavement abutting the new work shall be saw cut and the cut off material and laitance removed. Apply a tack coat in accordance with P-603 before new asphalt material is placed against it.

The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the asphalt mix shall begin along the centerline of a crowned section or on the high side of areas with a one way slope unless shown otherwise on the laydown plan as accepted by the DEN PM. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 15 feet (m) except where edge lanes require less width to complete the area. Additional screed sections attached to widen the paver to meet the minimum lane

width requirements must include additional auger sections to move the asphalt mixture uniformly along the screed extension.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least one foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m). On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the asphalt may be spread and luted by hand tools.

The DEN PM may at any time, reject any batch of asphalt, on the truck or placed in the mat, which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or overheated asphalt mixture. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the DEN PM, and if it can be demonstrated in the laboratory, in the presence of the DEN PM, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

Areas of segregation in the surface course, as determined by the DEN PM, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraph 401-3.3, Table 2 for the approved mix design. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

**401-4.13 Compaction of asphalt mixture.** After placing, the asphalt mixture shall be thoroughly and uniformly compacted by self-propelled rollers. The surface shall be compacted as soon as possible when the asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any surface defects and/or displacement occurring as a result of the roller, or from any other cause, shall be corrected at the Contractor's expense.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the asphalt to the roller, the wheels shall be equipped with a scraper and kept moistened with water as necessary.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power tampers.

Any asphalt that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

**401-4.14 Joints.** The formation of all joints shall be made to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid asphalt except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the

adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh asphalt against the joint.

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. Asphalt tack coat in accordance with P-603 shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint. The cost of this work shall be considered incidental to the cost of the asphalt.

**401-4.15 Saw-cut grooving.** Saw-cut grooving is not required.

**401-4.16 Diamond grinding.** Diamond grinding shall be completed prior to pavement grooving. Diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive.

Diamond grinding shall be performed with a machine designed specifically for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with a sufficient number of blades to create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Equipment or grinding procedures that cause ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted. Contractor shall demonstrate to the DEN PM that the grinding equipment will produce satisfactory results prior to making corrections to surfaces. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

**401-4.17 Nighttime paving requirements.** The Contractor shall provide adequate lighting during any nighttime construction. A lighting plan shall be submitted by the Contractor and approved by the DEN PM prior to the start of any nighttime work. All work shall be in accordance with the approved CSPP and lighting plan.

### **CONTRACTOR QUALITY CONTROL (CQC)**

**401-5.1 General.** The Contractor shall develop a Contractor Quality Control Program (CQCP) in accordance with Item C-100. No partial payment will be made for materials without an approved CQCP.

**401-5.2 Contractor quality control (QC) facilities.** The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The DEN PM shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The DEN PM will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

**401-5.3 Contractor QC testing.** The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications [ ] and as set forth in the approved CQCP. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A QC Testing Plan shall be developed as part of the CQCP.

**a. Asphalt content.** A minimum of two tests shall be performed per day in accordance with ASTM D6307 or ASTM D2172 for determination of asphalt content. When using ASTM D6307, the correction factor shall be determined as part of the first test performed at the beginning of plant production; and as part of every tenth test performed thereafter. The asphalt content for the day will be determined by averaging the test results.

**b. Gradation.** Aggregate gradations shall be determined a minimum of twice per day from mechanical analysis of extracted aggregate in accordance with ASTM D5444, ASTM C136, and ASTM C117.

**c. Moisture content of aggregate.** The moisture content of aggregate used for production shall be determined a minimum of once per day in accordance with ASTM C566.

**d. Moisture content of asphalt.** The moisture content shall be determined once per day in accordance with AASHTO T329 or ASTM D1461. CDOT Procedure CP43 is also an acceptable method of determining the moisture content of the asphalt.

**e. Temperatures.** Temperatures shall be checked, at least four times per day, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the asphalt at the plant, and the asphalt at the job site.

**f. In-place density monitoring.** The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

**g. Smoothness for Contractor Quality Control.**

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the DEN PM. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, of FHWA ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

**(1) Transverse measurements.** Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the DEN PM. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

**(2) Longitudinal measurements.** Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously material the first measurement shall start with one half of the length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 401-4.16 or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 401-6.1d(3). Areas that have been ground shall be sealed with a surface treatment in accordance with Item P-608. To avoid the surface treatment creating any conflict with runway or taxiway markings, it may be necessary to seal a larger area.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

**h. Grade.** Grade shall be evaluated daily to allow adjustments to paving operations when grade measurements do not meet specifications. As a minimum, grade shall be evaluated prior to and after the placement of the first lift and after placement of the surface lift.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically. The documentation will be provided by the Contractor to the DEN PM by the end of the following working day.

Areas with humps or depressions that exceed grade or smoothness criteria and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 401-4.16.

The Contractor shall repair low areas or areas that cannot be corrected by grinding by removal of deficient areas to the depth of the final course plus 1/2 inch and replacing with new material. Skin patching is not allowed.

**401-5.4 Sampling.** When directed by the DEN PM, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

**401-5.5 Control charts.** The Contractor shall maintain linear control charts for both individual measurements and range (i.e. difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day will be calculated and monitored by the QC laboratory.

Control charts shall be posted in a location satisfactory to the DEN PM and kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the DEN PM may suspend production or acceptance of the material.

**a. Individual measurements.** Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts shall use the job mix formula target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

**Control Chart Limits for Individual Measurements**

Sieve	Action Limit	Suspension Limit
3/4 inch (19.0 mm)	±6%	±9%
1/2 inch (12.5 mm)	±6%	±9%
3/8 inch (9.5 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (300 µm)	±3%	±4.5%
No. 200 (75 µm)	±2%	±3%
<b>Asphalt Content</b>	±0.45%	±0.70%
<b>Minimum VMA</b>	-0.5%	-1.0%

**b. Range.** Control charts shall be established to control gradation process variability. The range shall be plotted as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of  $n = 2$ . Should the Contractor elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for  $n = 3$  and by 1.27 for  $n = 4$ .

### Control Chart Limits Based on Range

Sieve	Suspension Limit
1/2 inch (12.5 mm)	11%
3/8 inch (9.5 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (300 µm)	6%
No. 200 (75 µm)	3.5%
<b>Asphalt Content</b>	0.8%

**c. Corrective Action.** The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

- (1) One point falls outside the Suspension Limit line for individual measurements or range; or
- (2) Two points in a row fall outside the Action Limit line for individual measurements.

**401-5.6 QC reports.** The Contractor shall maintain records and shall submit reports of QC activities daily, in accordance with Item C-100.

## MATERIAL ACCEPTANCE

**401-6.1 Acceptance sampling and testing.** Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the DEN PM at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

**a. Quality assurance (QA) testing laboratory.** The QA testing laboratory performing these acceptance tests will be accredited in accordance with ASTM D3666. The QA laboratory accreditation will be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing will be listed on the lab accreditation.

**b. Lot size.** A standard lot will be equal to one day's production divided into approximately equal sublots of between 400 to 600 tons. When only one or two sublots are produced in a day's production, the sublots will be combined with the production lot from the previous or next day.

Where more than one plant is simultaneously producing asphalt for the job, the lot sizes will apply separately for each plant.

**c. Asphalt air voids.** Plant-produced asphalt will be tested for air voids on a subplot basis.

**(1) Sampling.** Material from each subplot shall be sampled in accordance with ASTM D3665. Samples shall be taken from material deposited into trucks at the plant or at the job site in accordance with ASTM D979. The sample of asphalt may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to maintain the material at or above the compaction temperature as specified in the JMF.

**(2) Testing.** Air voids will be determined for each subplot in accordance with ASTM D3203 for a set of three compacted specimens prepared in accordance with ASTM D6925.

**d. In-place asphalt mat and joint density.** Each subplot will be tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

**(1) Sampling.** The Contractor will cut minimum 5 inch (125 mm) diameter samples in accordance with ASTM D5361. The Contractor shall furnish all tools, labor, and materials for cleaning, and filling the cored pavement. Laitance produced by the coring operation shall be removed immediately after coring, and core holes shall be filled within one day after sampling in a manner acceptable to the DEN PM.

**(2) Bond.** Each lift of asphalt shall be bonded to the underlying layer. If cores reveal that the surface is not bonded, additional cores shall be taken as directed by the DEN PM to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as directed by the DEN PM.

**(3) Thickness.** Thickness of each lift of surface course will be evaluated by the DEN PM for compliance to the requirements shown on the plans after any necessary corrections for grade. Measurements of thickness will be made using the cores extracted for each subplot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch (6 mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, will not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or subplot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the DEN PM to circumscribe the deficient area.

**(4) Mat density.** One core shall be taken from each subplot. Core locations will be determined by the DEN PM in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each subplot sample by the TMD for that subplot.

**(5) Joint density.** One core centered over the longitudinal joint shall be taken for each subplot that has a longitudinal joint. Core locations will be determined by the DEN PM in accordance with ASTM D3665. The bulk specific gravity of each core sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the lot. The TMD used to determine the joint density at joints formed between lots will be the lower of the average TMD values from the adjacent lots.

#### **401-6.2 Acceptance criteria.**

**a. General.** Acceptance will be based on the implementation of the Contractor Quality Control Program (CQCP) and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density, grade.

**b. Air Voids and Mat density.** Acceptance of each lot of plant produced material for mat density and air voids will be based on the percentage of material within specification limits (PWL). If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment will be determined in accordance with paragraph 401-8.1.

**c. Joint density.** Acceptance of each lot of plant produced asphalt for joint density will be based on the PWL. If the PWL of the lot is equal to or exceeds 90%, the lot will be considered acceptable. If the PWL is less than 90%, the Contractor shall evaluate the reason and act

accordingly. If the PWL is less than 80%, the Contractor shall cease operations and until the reason for poor compaction has been determined. If the PWL is less than 71%, the pay factor for the lot used to complete the joint will be reduced by five (5) percentage points. This lot pay factor reduction will be incorporated and evaluated in accordance with paragraph 401-8.1.

**d. Grade.** The final finished surface of the pavement shall be surveyed to verify that the grade elevations shown on the paving plans do not deviate more than 1/2 inch (12 mm) vertically.

The survey and documentation shall be stamped and signed by a licensed surveyor. Payment for sublots that do not meet grade for over 25% of the subplot shall not be more than 95%.

**e. Profilograph roughness for QA Acceptance.** Not used.

**401-6.3 Percentage of material within specification limits (PWL).** The PWL will be determined in accordance with procedures specified in Item C-110. The specification tolerance limits (L) for lower and (U) for upper are contained in Table 5.

**Table 5. Acceptance Limits for Air Voids and Density**

Test Property	Pavements Specification Tolerance Limits	
	L	U
<b>Air Voids Total Mix (%)</b>	2.0	5.0
<b>Surface Course Mat Density (%)</b>	92.8	-
<b>Base Course Mat Density (%)</b>	92.0	-
<b>Joint density (%)</b>	90.5	--

**a. Outliers.** All individual tests for mat density and air voids will be checked for outliers (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded, and the PWL will be determined using the remaining test values. The criteria in Table 5 is based on production processes which have a variability with the following standard deviations: Surface Course Mat Density (%), 1.30; Base Course Mat Density (%), 1.55; Joint Density (%), 1.55.

The Contractor should note that (1) 90 PWL is achieved when consistently producing a surface course with an average mat density of at least 94.5% with 1.30% or less variability, (2) 90 PWL is achieved when consistently producing a base course with an average mat density of at least 94.0% with 1.55% or less variability, and (3) 90 PWL is achieved when consistently producing joints with an average joint density of at least 92.5% with 1.55% or less variability.

**401-6.4 Resampling pavement for mat density.**

**a. General.** Resampling of a lot of pavement will only be allowed for mat density, and then, only if the Contractor requests same, in writing, within 48 hours after receiving the written test results from the DEN PM. A retest will consist of all the sampling and testing procedures contained in paragraphs 401-6.1d and 401-6.2b. Only one resampling per lot will be permitted.

(1) A redefined PWL will be calculated for the resampled lot. The number of tests used to calculate the redefined PWL will include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

**b. Payment for resampled lots.** The redefined PWL for a resampled lot will be used to calculate the payment for that lot in accordance with Table 6.

**c. Outliers.** Check for outliers in accordance with ASTM E178, at a significance level of 5%.

### **METHOD OF MEASUREMENT**

**401-7.1 Measurement.** Asphalt shall be measured by the number of tons of asphalt mixture, including binder, used in the accepted work. Batch weights or truck scale weights will be used to determine the basis for the tonnage.

### **BASIS OF PAYMENT**

**401-8.1 Payment.** Payment for a lot of asphalt meeting all acceptance criteria as specified in paragraph 401-6.2 shall be made based on results of tests for mat density and air voids. Payment for acceptable lots shall be adjusted according to paragraph 401-8.1c for mat density and air voids; and paragraph 401-6.2c for joint density, subject to the limitation that:

**a.** The total project payment for plant mix asphalt pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons (kg) of asphalt used in the accepted work.

**b.** The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

**c. Basis of adjusted payment.** The pay factor for each individual lot shall be calculated in accordance with Table 6. A pay factor shall be calculated for both mat density and air voids. The lot pay factor shall be the higher of the two values when calculations for both mat density and air voids are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either mat density or air voids is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both mat density and air voids are less than 100%. If PWL for joint density is less than 71% then the lot pay factor shall be reduced by 5% but be no higher than 95%.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 401-8.1a. Payment in excess of 100% for accepted lots of asphalt shall be used to offset payment for accepted lots of asphalt pavement that achieve a lot pay factor less than 100%.

Payment for sublots which do not meet grade in accordance with paragraph 401-6.2d after correction for over 25% of the subplot shall be reduced by 5%.

**Table 6. Price adjustment schedule<sup>1</sup>**

Percentage of material within specification limits (PWL)	Lot pay factor (percent of contract unit price)
96 – 100	106
90 – 95	PWL + 10
75 – 89	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject <sup>2</sup>

<sup>1</sup> Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment above 100% shall be subject to the total project payment limitation specified in paragraph 401-8.1a.

<sup>2</sup> The lot shall be removed and replaced. However, the DEN PM may decide to allow the rejected lot to remain. In that case, if the DEN PM and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50% of the contract unit price and the total project payment shall be reduced by the amount withheld for the rejected lot.

**d. Profilograph Roughness.** Not used.

**401-8.1 Payment.**

Payment will be made under:

Item P-401-8.1	Bituminous Base Course – per ton
Item P-401-8.2	Bituminous Surface Course – per ton

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates

**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM P-401 ASPHALT MIX PAVEMENT**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
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ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979	Standard Practice for Sampling Asphalt Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Asphalt Paving Mixtures
ASTM D1188	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Asphalt Paving Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Asphalt Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures

**TECHNICAL SPECIFICATIONS  
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ASTM D5361	Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084	Standard Test Method for Elastic Recovery of Bituminous Materials by Duclilometer
ASTM D6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder
ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyrotory Compactor.
ASTM D6995	Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (Gmm)
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E950	Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
AASHTO T329	Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
AASHTO T324	Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures
AASHTO T 340	Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA)

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Asphalt Institute (AI)

Asphalt Institute Handbook MS-26, Asphalt Binder  
Asphalt Institute MS-2Mix Design Manual, 7th Edition  
AI State Binder Specification Database

Federal Highway Administration (FHWA)

Long Term Pavement Performance Binder Program

Advisory Circulars (AC)

AC 150/5320-6      Airport Pavement Design and Evaluation

FAA Orders

5300.1      Modifications to Agency Airport Design, Construction, and  
Equipment Standards

Software

FAARFIELD

**END OF ITEM P-401**

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## Item P-405 Asphalt Treated Permeable Base (Central Plant Hot Mix)

### DESCRIPTION

**405-1.1 General.** This item shall consist of an open-graded asphalt treated permeable base (atpb) composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the plans.

Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished and approved before the placement of the next course.

### MATERIALS

**405-2.1 Aggregate.** Aggregates shall consist of crushed stone or crushed gravel with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 4 sieve shall be known as the coarse aggregate. The portion passing the No. 4 sieve and retained on the No. 200 sieve shall be known as the fine aggregate, and the portion passing the No. 200 sieve is mineral filler.

**a. Coarse Aggregate.** Coarse aggregate shall consist of sound, tough durable particles, free from adherent films of matter that would prevent thorough coating and bonding with the bituminous material and be free from organic matter and other deleterious substances. The percentage of wear shall not be greater than 40 percent when tested in accordance with ASTM C 131 (aggregate below 1 ½ inches). The sodium sulfate soundness loss shall not exceed 20 percent or the magnesium sulfate soundness loss shall not exceed 13 percent, after five cycles, when tested in accordance with ASTM C 88.

The source of coarse aggregate shall be from quarried rock or river gravel. No slag shall be permitted. All aggregates shall have demonstrated a satisfactory service record of at least 10 years duration under similar conditions of service and exposure. Aggregate shall contain at least 90 percent by weight of crushed pieces having two or more fractured faces and 85 percent by weight having at least one fractured face. The area of each face shall be equal to at least 75 percent of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. Fractured faces shall be obtained by artificial crushing. The aggregate shall not contain more than a total of 8 percent, by weight, of flat particles, elongated particles, and flat and elongated particles, when tested in accordance with ASTM D 4791 with a total value 31 of 5:1.

**b. Fine Aggregates.** Fine aggregate shall consist of clean, sound, durable, angular shaped particles produced by crushing stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls.

The fine aggregate, including any blended material for the fine aggregate, shall have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification. The fine aggregate shall not contain more than 15 percent natural sand by weight of total aggregates.

The aggregate shall have sand equivalent values of 30 or greater when tested in accordance with ASTM D 2419.

c. **Sampling.** ASTM D 75 shall be used in sampling coarse and fine aggregate and ASTM C 183 shall be used in sampling mineral filler.

**405-2.2 Bituminous Material.** The bituminous material shall be viscosity grade PG 64-22 conforming to ASTM D3381, Table 2. The material shall not be mixed above the allowable maximum mixing temperature of 325 °F nor below a minimum temperature of 275 °F.

The Contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the DEN Project Manager before permission is granted for use of the material. The vendor's certified test report for the bituminous material can be used as a basis for final acceptance. However, the DEN PM reserves the right to have the material tested and reject it if the asphalt cement does not meet the specifications.

**405-2.3 Anti-Stripping Agent.** Hydrated lime shall be added at a minimum dosage rate of 0.5 percent by weight of the aggregate. The amount of hydrated lime used shall be sufficient to produce a coated area above 95 percent and added to the mix design by an approved method.

## COMPOSITION

**405-3.1 Composition OF MIXTURE.** The bituminous plant mix shall be composed of a mixture of aggregate, bituminous material and lime. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

**405-3.2 Job Mix Formula.** No bituminous mixture shall be produced for payment until the DEN PM or Designer has given written approval of the job mix formula. The job mix shall be prepared by a certified laboratory at the Contractor's expense and shall remain in effect for the duration of the project. The job mix formula shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, the amount of anti-strip agent to be added (minimum of one half of one percent by weight), and a single temperature for the mixture as it is discharged into the hauling units. Proper asphalt content shall be determined by mixing trial batches in the laboratory.

The job mix formula shall be submitted to the DEN PM at least 30 days prior to the start of paving and shall include:

- a. Percent passing each sieve size and gradation requirements.
- b. Percent of asphalt cement.
- c. Asphalt viscosity.
- d. Mixing temperature range.
- e. Temperature of mix when discharged from the mixer.
- f. Temperature viscosity relationship of the asphalt cement.
- g. Percent of wear (LA abrasion).
- h. Plasticity Index and Liquid Limit of fine aggregate.
- i. Percent fractured faces.
- j. Percent elongated particles.
- k. Anti-strip agent.

The Contractor shall submit samples to the DEN Project Manager, upon request, for job mix formula verification testing.

The combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation shown in Table 1 when tested in accordance with ASTM C 136 and ASTM C 117.

**405-3.3 Aggregate Gradation.** The aggregate shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradations specified in Table 2, when tested in accordance with ASTM Standards C 117 and C 136. The gradation shall be on the course side of the Master Band.

TABLE 1 – AGGREGATE – ASPHALT TREATED PERMEABLE BASE

Sieve Designation (Square Openings)	Job Mix Tolerances
1 ½ Inch	100
1 Inch	95-100
1/2 Inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-2

TABLE 1 – AGGREGATE – ASPHALT TREATED PERMEABLE BASE

Sieve Designation (Square Openings)	Job Mix Tolerances
Bituminous Cement	2.0-3.5% by weight of total mix

The gradation in Table 1 represents the limits which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 1 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from course to fine.

The gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves will be subject to appropriate adjustments when aggregates of varying specific gravities are used. The adjustments to the job mix gradation curve should result in a curve of the same general shape as the median curve of the gradation band in Table 1 and fall within the gradation band.

The Asphalt Institutes Manual Series No. 2 (MS-2) contains a convenient procedure for "adjusting" the job mix gradation when aggregates of non-uniform specific gravity are proposed for use.

The optimum percent bituminous cement for the ATPB shall be established in accordance with Innovative Pavement Research Foundation Report IPRF-01-G-002-02-1(G); Stabilized and Drainable Base for Rigid Pavement, Appendix C, section ATPB 3.2 Mix Design - which states the following:

"The Job Mix Formula (JMF) shall establish a single percentage of dry weight of aggregate passing each required sieve size, a single percentage of asphalt cement to be added to the aggregate based on the weights of the total mix, and a single temperature for the mixture as it is discharged into the hauling units. When tested in accordance with ASTM C136 & ASTM C117, the combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation specified in Table 1. The gradation band shown in Table 1 shall be applied to the JMF and used for job control. When the component aggregates are blended together, mixed with the specified amount of asphalt cement at a temperature of 250-degrees F, and compacted at 150-degrees F with 35 blows of a standard Marshall hammer, the JMF shall have a permeability of not less than 500 ft/day nor more than 1,500 ft/day when tested in accordance with ASTM D 2434/AASHTO T 215 (Constant Head Permeability Test). The JMF shall have a minimum asphalt binder content of 2.0 percent by weight, which can be adjusted upward to 3.5 percent to provide stability under rollers during construction and to meet the desired permeability requirements."

The job mix tolerances shown in Table 2 shall be applied to the job mix formula to establish a job control grading band. The full tolerances still will apply if application of the job mix tolerances results in job control grading band outside the master grading band.

TABLE 2 – JOB MIX FORMULA TOLERANCES (BASED ON A SINGLE TEST)

Material	Tolerance Plus or Minus
Aggregate Passing No. 4 Sieve or Larger	7 Percent
Aggregate Passing Numbers 8 and 16 Sieves	6 Percent
Aggregate Passing Numbers 30 and 50 Sieves	5 Percent
Aggregate Passing Numbers 100 and 200 Sieves	3 Percent
Bitumen Content (Individual Tests)	0.45 Percent
Bitumen Content (Moving Average of Last 5 Tests)	0.25 Percent Variation
Temperature of Mix*	20 <sup>o</sup> F
* Unless otherwise approved by the DEN Project Manager.	

The aggregate gradation may be adjusted within the limits of Table 1 as directed, without adjustments in the contract unit prices.

Should a change in sources of materials or differing components be made, a new job mix formula shall be established before the new material is used.

Deviation from the final approved design for bituminous content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extractions.

Dry aggregate gradations will be made at least twice daily. Extraction tests will be made twice daily, and the results averaged and analyzed as one test for the day's production.

The mixture shall be tested for bitumen content in accordance with ASTM D2172 or ASTM D6307 and for aggregate gradation in accordance with ASTM C136 and ASTM C117.

**405-3.4 Job Mix Formula (JMF) Laboratory.** The Contractor's laboratory used to develop the JMF shall be accredited in accordance with ASTM D3666. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the JMF must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the DEN Project Manager prior to start of construction.

**405-3.5 Test Section.** At least one full day prior to full production, the Contractor shall prepare a quantity of ATPB mixture according to the approved job mix formula. The amount of mixture should be sufficient to construct a test section at least 100 feet long BY 100 feet wide and of the same depth specified on the plans. The test area will be designated by the DEN PM or proposed by the Contractor and approved by the DEN PM. The underlying pavement on which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment to be used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. No bituminous mixture shall be produced for payment prior to successful placement of and acceptance of a test strip by the DEN PM.

For the ATPB, plant material and field cores will be taken to perform aggregate gradation, bitumen content, permeability, and temperature. Density and Marshall Stability Tests need not be performed. In no case will the plant-produced mix be considered acceptable if the mix properties of the test section do not meet the requirements of the mix design criteria.

If the test section should prove to be unsatisfactory, the necessary adjustments to plant operation, and/or placement procedures shall be made. Additional test sections, as required, shall be constructed, and evaluated for conformance to the specifications. When the test section does not conform to specification requirements the test section shall be removed and replaced at the Contractors expense. Full production shall not begin without approval of the DEN Project Manager. The asphalt content may be adjusted during the test section if deemed appropriate. Any successful adjustment shall be used as the target asphalt content.

### QUALITY CONTROL

**405-4.1 General.** The Contractor will provide and maintain a quality control system that will require the Contractor to provide reasonable assurance that all materials and completed construction submitted for acceptance conform to the Contract requirements whether manufactured or processed by the Contractor or procured from subcontractors or vendors.

A job mix shall be required by Section 405-3.02 of this specification prior to start of production, and whenever a change in materials warrants retesting.

**405-4.2 Quality Control Testing.** The Contractor shall be responsible to provide samples of bituminous and aggregate materials that are proposed for use. A statement for the proposed source and character of the materials shall also be submitted with the appropriate testing requirements for approval prior to use. The Contractor shall require the manufacturer or producer of the bituminous and aggregate materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials that have been tested and approved for the intended use shall be acceptable.

The Contractor shall furnish the vendor's certified test reports for each carload or equivalent of bituminous material shipped to the project. The report shall be delivered to the DEN PM before permission is granted to use the material. The vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All test reports shall be subject to verification by testing sample materials received for use on the project.

Extraction tests for bitumen content and aggregate gradation will be made at least twice daily. Sample aggregate for gradation in accordance with ASTM D 979 or D 75, as applicable. The mixture will be tested for bitumen content in strict conformance with ASTM D 2172, D 4125, or D 6307. If methods D 2172 or D 6307 are used, test aggregate for gradation in accordance with ASTM D 5444. If method D 4125 is used, test aggregate for gradation in accordance with ASTM C 136 and C 117.

### CONSTRUCTION METHODS

**405-5.1 Weather Limitations.** The mixture shall not be placed upon a wet surface or when the

surface temperature of the underlying course is less than specified in Table 4, or the chill factor is less than 35°F.

The date for computing the chill factor can be obtained from airport weather equipment or nearby radio stations and Table 5. If the haul distance for the asphaltic concrete is more than 15 miles, paving operations shall not be allowed after October 1 without written approval of the DIA Project Manager.

TABLE 3 – BASE TEMPERATURE LIMITATIONS

Mat Thickness	Base Temperatures (min.)	
	°F	°C
3 Inch (7.5 cm) or Greater	45	7
Greater Than 1 Inch (2.5 cm) But Less Than 3 Inches (7.5 cm)	50	10

TABLE 4 – WIND CHILL TABLE

Wind Speed MPH	Air Temperature °F			
	45	40	35	30
5	43	37	32	27
10	34	28	22	16
15	29	23	6	9
20	26	19	12	4

- a. **Other Limitations.** The excavation of this material is temperature and light sensitive. Due to this, methods of trenching and placing conduit shall be developed

**405-5.2 Bituminous Mixing Plant.** If the supplier is equipped with an automated plant, the automatic feature shall be used in the production of bituminous material for the project. If the supplier is equipped with a recording feature, it also shall be used. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. The storage area shall be neat and orderly, and the separate stockpiles shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (A) except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under (B), continuous mixing plants shall conform to the requirements under (C) and drum mixers shall conform to the requirements under (D).

- a. **Requirements for All Plants.** Mixing plants shall be of sufficient capacity to adequately

handle the proposed bituminous construction. The mixing plant shall have a minimum hourly production of 100 tons.

1. **Plant Scales.** Scales shall be accurate to 0.5 percent of the required load. Poises shall be designated to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales, the contractor may provide an approved automatic printer system to print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weight ticket for each load. Scales shall be inspected for accuracy and sealed as often as the DIA Project Manager may deem necessary. The Contractor shall have on hand not less than ten 50-pound weights for testing the scales.
2. **Equipment for Preparation of Bituminous Material.** Tanks for storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. Heating shall be accomplished by approved means so that flames will not contact the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring quantities and for sampling the material in the storage tanks.
3. **Cold Feeders.** The plant shall be provided with accurate mechanical or electrical means for uniformly feeding the aggregates into the drier to obtain uniform production and temperature. When added mineral filler is specified, a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders.
4. **Drier.** The plant shall include a drier(s) which continuously agitate the aggregate during the heating and drying process.
5. **Screens.** Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities more than the full capacity of the mixer, shall be provided. In states where the highway departments do not require hot bin screens, the screenless plant shall be permitted if the mix can be produced within the specification limits and tolerances. For the batch plant and continuous mix plants, gradation shall be taken on the aggregate without asphalt. This would be after the aggregate has been combined after passing through the dryer.

When drum mixers are used, the gradation test shall be made by the extraction method. Two extraction samples shall be taken, and the results combined, averaged, and analyzed as one test. After production has started and an acceptable correlation can be made between hot combined aggregate samples and the cold feed samples, then only cold feed gradations shall be required; however, frequent checks shall be made.

6. **Bins.** The plant shall include storage bins, if required, of sufficient

capacity to supply a mixer operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. When used, separate dry storage shall be provided with overflow pipes of such size and at such location to prevent backup of material into other compartments or bins. Each compartment shall be provided with its own individual outlet gate to prevent leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples may be obtained readily. Bins shall be equipped with adequate telltale devices which indicate the position of the aggregates in the bins at the lower quarter points.

7. Bituminous Control Unit. Satisfactory means, either by weighing or metering shall be provided to obtain the specified amount of bituminous material in the mix. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.
8. Thermometric Equipment. An armored thermometer of adequate range shall be placed in the bituminous feed line at a suitable location near the charging valve of the mixer unit. The plant shall also be equipped with an approved thermometric instrument placed at the discharge chute of the drier to indicate the temperature of the heated aggregate. The DEN Project Manager may require replacement of any thermometer by an approved temperature recording apparatus for better regulation of the temperature of aggregates.
9. Dust Collector. The plant shall be equipped with a dust collector to waste any material collected. This equipment shall operate within the state EPA requirements.
10. Safety Requirements. Adequate and safe stairways to the mixer platform and sampling point shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a suitable device to enable the DEN Project Manager to obtain samples and mixture temperature data. Means shall be provided to raise and lower scale calibration equipment, sampling equipment, and other similar equipment between the ground and the mixer platform. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded. Ample and unobstructed passage shall be always maintained in and around the truck loading area. This area shall be kept free of drippings from the mixing platform.
11. Testing Laboratory. The Contractor or producer shall provide a testing laboratory for control testing functions during periods of mix production, sampling, and testing and whenever materials subject to provisions of these specifications are being supplied or tested. The Contractor shall equip the laboratory with tables, sinks, desks, and other required furniture and shall provide all utilities such as water and electricity for operation of the laboratory. The testing laboratory company shall be responsible for furnishing the actual testing equipment.

**b. Requirements for Batching Plants:**

1. Weigh Box or Hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.
- 2.
2. Bituminous Control. The equipment used to measure the bituminous material shall be accurate to within  $\pm 0.5$  percent. The bituminous material bucket shall be non-tilting type with a loose sheet metal cover. The length of the discharge opening, or spray bar shall be not less than three-fourths of the length of the mixer, and it shall discharge directly into the mixer. The bituminous material bucket discharge shall discharge directly into the mixer. The bituminous material bucket discharge valve (s), and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15% more than the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15% in excess of the quantity of bituminous material used in one batch. The controls shall be constructed to lock at any dial setting and automatically reset to that reading after the addition of each batch of bituminous material. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has begun. The size and spacing of the spray bar openings shall provide uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall have a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

3. Mixer. The batch mixer shall be of an approved type capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust. The clearance of blades from all fixed and moving parts shall not exceed 1 inch for surface course and 1 ½ inches for base course mixes.
4. Control of Mixing Time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall

lock mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening and the weigh box gate and the introduction of bituminous material. The wet mixing period is the interval of time between the introduction of bituminous material and the opening of the mixer gate.

The timing control shall be flexible and capable of setting of 5-second intervals or less throughout a 3-minute cycle. A mechanical batch counter shall be installed as a part of the timing device and shall be so designated to register only completely mixed batches.

The setting of time intervals shall be as directed by the Contactor's QC Manager. The case covering the timing device shall then be locked until a change is required in the timing periods.

**c. Requirements for Continuous Plants:**

1. Aggregate Proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means and provided with a lock.

Indicators shall be provided for each gate to show the respective gate opening in inches.

2. Weight Calibration of Aggregate Feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provisions shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples of not less than 200 pounds. Accurate scales shall be provided by the Contractor to weigh such test samples.
3. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control shall be by interlocking mechanical means or by any other positive method satisfactory to the DIA Project Manager.
4. Mixer. The plant shall include a continuous mixer of an approved type adequately heated and capable of producing a uniform mixture within the job mix tolerances. It shall be equipped with a discharge hopper with dump gates to permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular positioning on the shafts and shall

be reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed per minute for each aggregate used.

**d. Requirements for Drum Mixers.**

1. Exclusions. Paragraphs 4.02. (A.4 through A.9) do not apply to drum mixers.
2. Aggregate Delivery System. An automatic plant shutoff shall be provided to operate when any aggregate bin becomes empty. Provisions shall be provided for conveniently sampling the full flow of materials from each cold feed and the total cold feed. Total cold feed shall be weighed continuously. The weighing system shall have an accuracy of 0.5 percent when tested for accuracy. The plant shall provide positive weight control of the cold aggregate feed by use of a belt scale, or other appropriate device, which will automatically regulate the feed gate and permit instant correction of variations in load. The cold feed flow shall be automatically coupled with the asphalt flow to maintain the required proportions of each material. Provisions shall be made for introducing the moisture content of the cold feed aggregates into the belt weighing signal and correcting wet aggregate weight to dry aggregate weight. Screens or other suitable devices which will reject oversize particles or lumps of aggregate that have been cemented together shall be installed in the feeder mechanism between the bins and the dryer drum.

Dry weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time and totalized.

3. Bituminous Material and Additive Delivery Systems. Satisfactory means of metering shall be provided to introduce the proper amount of bituminous material and additives into the mix. Delivery systems shall prove accurate to plus or minus 1 percent when tested for accuracy. The bituminous material and additive delivery shall be interlocked with the aggregate weight. The bituminous material and additive flow shall be displayed digitally in appropriate units of volume (or weight) and time shall be totalized.
4. Thermometric Equipment. A recording thermometer of adequate range shall be located to indicate the temperature of the bituminous material in storage. The plant shall also be equipped with approved recording thermometers, pyrometers, or other approved recording thermometric instruments at the discharge chute of the drum mixer.
5. Drum Mixer. A drum mixer of satisfactory design shall be provided. It shall be capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the paving mixture requirements and capable of producing a uniform mixture. If the quality requirements of sub-item 404-3.01 cannot be met, the Contractor will be required to utilize

either batch or continuous mix plants.

- e. Inspection Plant. The DEN Project Manager or his authorized representative shall have access, at all times, to all parts of the paving plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.

**405-5.2 Hauling Equipment.** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. To prevent the mixture from adhering to them, the beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall be covered during the delivery of material from the plant to the lay-down machine. When it is necessary to prevent crusting at the surface or the sides or a loss in heat below the specified minimum temperature, the material shall be delivered in insulated truck beds.

**405-5.4 Bituminous Spreaders.** Bituminous material spreaders shall be the self-propelled type, equipped with hoppers, tamping or vibrating devices, distributing screws, adjustable screeds, equipment for heating the screeds, and equalizing devices. The spreader shall be capable of spreading hot bituminous mixtures without tearing, shoving, or gouging, and capable of producing a finished surface conforming to the smoothness requirements specified hereinafter. The spreader shall be capable of confining the edges of the strips to true lines without the use of stationary side forms, and of placing the course to the required thickness. Spreaders shall be designed to operate forward at variable speeds and in reverse at traveling speeds of not less than 100 feet per minute. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh-laid mix during operation will not be permitted. The paver shall not damage the underlying course. The Contractor shall keep the paver in good operational condition at all times. If extensions are used, they shall contain the same vibration and screed heater equipment as the basic paver. This does not apply when extensions are used for fillet construction. Bituminous material spreaders shall be equipped with electronic sensing devices for grade control. The devices shall be capable of utilizing the string line long-ski sled, and automatic transverse grade control methods for controlling grades. The long-ski sled shall have a minimum length of 25 feet. The controls shall be so arranged that independent longitudinal grade controls can be operated simultaneously on both sides of the machine or independently on either side. The electronic controls shall be arranged so that the machine can be controlled automatically, semi-automatically, or manually.

**405-5.5 Rollers.** Rollers will be tandem, steel-wheeled rollers weighing between 6 and 10 tons. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture as directed by the DEN Project Manager.

**405-5.6 Preparation of Bituminous Material.** The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of bituminous material to the mixer at a uniform temperature.

**405-5.7 Preparation of Mineral Aggregate.** The aggregate for the mixture shall be dried and heated at the central mixing plant before entering the mixer. When introduced into the mixer,

the combined aggregate moisture content (weighted according to the composition of the blend) shall be less than 0.25 percent for aggregate blends with water absorption of 2.5 percent or less and less than 0.50 percent for aggregate blends with water absorption greater than 2.5 percent. Water absorption of aggregates shall be determined by ASTM C 127 and C 128. The water absorption for the aggregate blend shall be the weighted average of the absorption values for the coarse aggregate retained on the No. 4 sieve (4.75 mm) and the fine aggregate passing the No. 4 sieve (4.75 mm). The water content test will be conducted in accordance with ASTM C 566. In no case shall the moisture content be such that foaming of the mixture occurs prior to placement. At the time of mixing, the temperature of the aggregate shall be within the range specified in the job mix formula. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. Particular care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The aggregate shall be screened to specified sizes and conveyed in separate bins ready for mixing with bituminous material. The use of a drum mix plant may be approved provided that the limitations in moisture and temperature are adhered to.

In no case shall the temperature of the aggregate be more than 25°F above the temperature of the bituminous material. Mixing shall continue until all particles are coated uniformly.

**405-5.8 Preparation of Bituminous Mixture.** The aggregates and the bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate are secured. Wet mixing time shall be approved by the DEN Project Manager for each plant and for each type of aggregate used. Normally, the mixing time after introduction of bituminous material should not be less than 30 seconds. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per seconds by the mixer.

$$\text{Mixing Time (Seconds)} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

The dry mixing time in the batch plant shall be the time required to blend the dry aggregate in uniform mixture. The wet mixing time begins with the introduction of the asphalt cement to the pugmill and ends with the opening of the discharge gate.

Prolonged exposure to air and heat in the pugmill hardens the asphalt film on the aggregate through oxidation. Therefore, the mixing time should be the shortest time required to obtain uniform distribution of aggregate sizes and thorough coating of aggregate particles with the bituminous material.

In no case shall the bituminous mixture be stored in storage silos or surge bins.

**405-5.9 Transporting, Spreading and Finishing.** The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Section 4.03.

Deliveries shall be scheduled so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight unless adequate artificial lighting is provided. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to ambient temperatures or for eight hours, whichever is longer.

Immediately before placing the bituminous mixture, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed.

Upon arrival, the mixture shall be spread to the full width by an approved bituminous paver. The mixture shall be placed at a temperature of not less than 2500F. It shall be struck off in uniform layer of such depth that, when the work is completed, it shall have a minimum thickness of 3 inches and no more than 4.5 inches per lift. The required thickness of the initial course shall be constructed to conform to the grade and contours indicated on the plans. The minimum total thickness required is 4 inches in the GSE pavement area and 6 inches in the Aircraft Apron pavement area. Excessive waiting or delay in placement at the job site shall not be allowed and the mix found to be outside of the specified temperature range will not be accepted. Bleeding and rich spots resulting from segregation during transportation shall not be accepted.

Unless otherwise directed, placing shall begin along the highest elevation areas to be paved and proceed to the lower elevation areas. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet, except where edge lanes require strips less than 10 feet to complete the area. The longitudinal joint in one layer shall offset that in the layer immediately below by at least 1 foot. Transverse joints in one layer shall be offset by at least 2 feet from transverse joints in the previous layer (at the phase limits).

The responsible party shall set grade requirements for each paving lane.

After the first lane of each lift is constructed, a joint matcher (short-ski) shall be used on the previous laid lane. The free edge shall be controlled as specified hereinbefore.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mix may be spread, raked, and luted by hand tools.

**405-5.10 Compaction of Mixture.** After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Approximately 2 or 3 complete passes should be sufficient to compact the mixture. Rolling will be withheld until the mixture has cooled between 150°F to 175°F. Rolling of the mixture shall be performed in accordance with the approved test section. Rolling shall be initiated with the drive wheel toward the paving machine. The sequence of rolling for the first paving lane should be to first roll the lower edge (with reference to the transverse slope) of the lane and then roll the upper edge. The interior of the lane should then be rolled from the lower side toward the upper with overlapping roller paths. On adjoining paving lanes, rolling shall begin by overlapping the joint (with the previous lane) by 6 to 8 inches and then rolling the outside edge of the new lane. The interior is rolled from the outside edge toward the compacted joints with overlapping wheel paths. Alternate paths of the roller shall be of slightly different lengths.

The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture. The rollers shall not travel faster than 3 MPH. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and fresh mixture. The roller shall not be permitted to stand static on the hot material.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture and true to grade and cross section, no movement of the mixture can be noticed, and no roller marks are on the surface.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened; however, excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt or in any way defective shall be removed and placed with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Spreading of the mixture shall be done carefully with particular attention given to making the operation as continuous as possible. Hand working shall be kept to an absolute minimum.

Skin patching and hand working of the ATPB mixture will not be allowed.

**405-5.11 Joints.** The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.

The joints between old and new pavements or between successive day's work or between phases, or joints that have become cold because of any delay, shall be carefully made in such manner as to insure a continuous bond between old and new sections of the course. All contact surfaces of previously constructed pavements that have become coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back with an approved power saw, as directed. The faces of these joints shall be painted with a thin coat of tack conforming to P-603.

When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. The joint shall be rolled perpendicular to the paving lane with the roller overlapping the new material approximately one foot. Boards or other devices shall be placed on the edges of the paving lane to prevent roll down of the edges.

All joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean sound surface for the full depth of the course.

**405-5.12 Surface Tests.** Tests for conformity with the specified slope and grade shall be made by the Contractor's Quality Control personnel immediately after initial compaction. Any variation shall be corrected by the removal or addition of material and by continuous rolling. Unless otherwise specified in writing, the Contractor shall provide a 12-foot straightedge on the job at all times.

After the completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected. All corrective work shall be done at the Contractor's expense. The finished surface shall not vary more than ½ inch when tested with a 12-foot straightedge applied parallel with, and/or at right angles to the

paving lane direction; and shall not vary from the grade line, elevations, and cross sections shown on the contract drawings by more than ½ inch. Verification of final grades shall be by survey on a 20-foot grid. The Contractor shall correct areas varying in excess of this amount by removing and replacing defective work when directed by the DEN Project Manager.

**405-5.13 Maintenance.** The completed drainage layer shall be maintained by the Contractor in a condition to meet all specification requirements until the PCC pavement has been placed.

## **MATERIAL ACCEPTANCE**

**405-6.1 Acceptance Testing.** The DEN Project Manager, at no cost to the Contractor, shall perform all acceptance sampling and testing. Approval and continued acceptance of a satisfactory mix shall be based on the following:

Field samples of the ATPB mixture shall be taken at the point of discharge in hauling units and tested to control uniformity in bituminous content and gradation. Samples shall be taken in accordance with ASTM D 979 and prepared in accordance with ASTM D 2172 or ASTM D 6307. One sample shall be taken from each lot on a random basis in accordance with procedures contained in ASTM D 3665. A lot shall consist of 1,000 tons or 1/2 day's production, whichever is less. Should the average bituminous content for any two consecutive lots not fall within job mix tolerances indicated in Table 2, the Contractor shall cease production until such out-of-tolerance conditions have been remedied. Any material, placed after the contractor has been informed of two consecutive failing tests, shall be rejected and removed at the Contractor's expense. A/C content will be determined by calibrated extraction oven in accordance with ASTM D 6307. The Contractor will provide samples, as required, for proper oven calibration.

Aggregate from each hot bin or aggregate feed shall be sampled on a random basis and tested for gradation analysis in accordance with ASTM C136 and ASTM C117. One sample shall be taken on a random basis in accordance with ASTM D 3665 for each lot. A lot shall consist of 500 tons or 1/4 day's production, whichever is less. If any two consecutive samples fail to meet the tolerances of the job mix formula gradation, the Contractor shall cease plant production until such out of tolerance conditions have been remedied. Any material, placed after the contractor has been informed of two consecutive failing tests, shall be rejected and removed at the Contractor's expense.

Completed ATPB shall be determined "acceptable" or "unacceptable" on the basis of visual inspection by the DEN PM. The DEN PM will notify the Contractor of unsatisfactory visual defects in the completed bituminous base course such as non-uniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture during the roller operations, or nonconformance to the surface smoothness criteria specified. Unsatisfactory ATPB shall be removed and replaced at the Contractor's expense as directed by the DEN PM.

"Unacceptable" ATPB shall be removed, leaving a vertical face at the remaining ATPB. The underlying surface shall be cleaned, and a tack coat applied prior to replacing the ATPB. Such rework shall be at the Contractor's expense. Unacceptable ATPB shall not be measured for payment.

Should gradation analysis or A/C content fail to meet the tolerances of the job mix formula, the

DEN PM may order another analysis in addition to the two analyses required each day to confirm the results of the previous tests, or tell the Contractor to cease plant production until such out-of-tolerance conditions have been corrected.

Thickness of ATPB shall be evaluated by the DEN PM for compliance to the requirements shown on the plans. To determine the thickness of the finished ATPB, the DEN PM shall take one core sample, not less than 2 inches (5 cm) in diameter, at random from each unit of the completed ATPB area. A unit of the completed area shall be one paving lane wide by prescribed length of the phase.

When the measurement of any core is less than the minimum allowable thickness, as shown in Table 6, additional cores shall be taken at 20-foot intervals (parallel to and at right angles to the paving lane) until the completed ATPB is within such minimum thickness for the subunit being tested. Out-of-tolerance areas shall be repaired at the Contractor's cost. If the average of the area in question is below the minimum thickness requirement, the area shall be reviewed for payment adjustment or repaired to meet the minimum thickness requirement.

**TABLE 5 – ALLOWABLE FINISHED ATPB THICKNESS**

Area	Minimum (in.)
GSE Pavement Area	4.0
Bitumen*	0.40 Percent
Aircraft Apron Pavement Area	6.0

## **METHOD OF MEASUREMENT**

### **405-7.1 Measurement**

Asphalt Treated Permeable Base (ATPB) Course shall be measured by the number of square yards as specified in-place, complete and accepted by the DEN Project Manager.

## **BASIS OF PAYMENT**

### **405-8.1 PAYMENT**

Payment for accepted Asphalt Treated Permeable Base (ATPB) Course shall be made at the full or adjusted contract unit price per square yard. This price shall be full compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Item P-405-8.1 Asphalt Treated Permeable Base Course (5 - 7 Inches) - per square yard

## **TESTING REQUIREMENTS**

ASTM D 75	Sampling Aggregates
ASTM C 33	Concrete Aggregate
ASTM C 88	Soundness of Aggregates by Use of Sodium or Magnesium Sulfate
ASTM C 117	Materials Finer than No. 200, Sieve in Mineral Aggregates by Washing
ASTM C 127	Density, Specific Gravity and Absorption of Coarse Aggregates
ASTM C 128	Density, Specific Gravity, and Absorption of Fine Aggregate
ASTM C 131	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates (Dry)
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM C 566	Total Evaporable Moisture Content of Aggregate by Drying
ASTM D 693	Crushed Aggregate for Macadam Pavements
ASTM D 979	Sampling Bituminous Paving Mixtures
ASTM D 995	Mixing Plants for Hot-Mixed Hot-Laid Bituminous Paving Mixtures
ASTM D 2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2434	Constant Head Permeability Test
ASTM D 2741	Susceptibility of Polyethylene Bottles to Soot Accumulation
ASTM D 3665	Random Sampling of Paving Materials
ASTM D 3666	Minimum Requirements for Agencies Testing and

	Inspecting Bituminous Paving Materials
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder
ASTM D 6926	Preparation of Bituminous Specimens Using MARSHALL Apparatus

**END OF SECTION P-405**

## Item P-501 Cement Concrete Pavement

### DESCRIPTION

**501-1.1** This work shall consist of pavement composed of cement concrete with reinforcement and without reinforcement constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans. The terms cement concrete, hydraulic cement concrete, and concrete are interchangeable in this specification.

### MATERIALS

#### 501-2.1 Aggregates.

**a. Reactivity.** Fine and Coarse aggregates to be used in PCC on this project shall be tested and evaluated by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Tests must be representative of aggregate sources which will be providing material for production. ASTM C1260 and ASTM C1567 tests may be run concurrently.

(1) Coarse aggregate and fine aggregate shall be tested separately in accordance with ASTM C1260, however, the length of test shall be extended to 28 days (30 days from casting). Tests must have been completed within 6 months of the date of the concrete mix submittal.

(2) The combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

(3) If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662 in lieu of ASTM C1567. If lithium nitrate admixture is used, it shall be nominal 30%  $\pm$ 0.5% weight lithium nitrate in water. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

**b. Fine aggregate.** Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and the parameters identified in the fine aggregate material requirements below. Fine aggregate material requirements and deleterious limits are shown in the table below.

<b>Fine Aggregate Material Requirements</b>		
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Sand Equivalent	45 minimum	ASTM D2419
Fineness Modulus (FM)	$2.50 \leq FM \leq 3.40$	ASTM C136
<b>Limits for Deleterious Substances in Fine Aggregate for Concrete</b>		
Clay lumps and friable particles	1.0% maximum	ASTM C142
Coal and lignite	0.5% using a medium with a density of Sp. Gr. of 2.0	ASTM C123
Total Deleterious Material	1.0% maximum	

**c. Coarse aggregate.** The maximum size coarse aggregate shall be 1-1/2 inch.

Aggregates delivered to the mixer shall be clean, hard, uncoated aggregates consisting of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates shall have no known history of detrimental pavement staining. Steel blast furnace slag shall not be permitted. Coarse aggregate material requirements and deleterious limits are shown in the table below; washing may be required to meet aggregate requirements.

#### **Coarse Aggregate Material Requirements**

<b>Material Test</b>	<b>Requirement</b>	<b>Standard</b>
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 for any size group coarser than 3/8 (9.5 mm) sieve <sup>1</sup>	ASTM D4791
Bulk density of slag <sup>2</sup>	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29
D-cracking (Freeze-Thaw) <sup>3</sup>	Durability factor $\geq 95$	ASTM C666

<sup>1</sup> A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

<sup>2</sup> Only required if slag is specified.

<sup>3</sup> Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not

have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

#### Limits for Deleterious Substances in Coarse Aggregate

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (75 µm)	ASTM C117	1.0 <sup>1</sup>
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert <sup>2</sup> (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	0.1 <sup>3</sup>

<sup>1</sup> The limit for material finer than 75-µm is allowed to be increased to 1.5% for crushed aggregates consisting of dust of fracture that is essentially free from clay or shale. Test results supporting acceptance of increasing limit to 1.5% with statement indicating material is dust of fracture must be submitted with Concrete mix. Acceptable techniques to characterizing these fines include methylene blue adsorption or X-ray diffraction analysis.

<sup>2</sup> Chert and aggregates with less than 2.4 specific gravity.

<sup>3</sup> The limit for chert may be increased to 1.0 percent by mass in areas not subject to severe freeze and thaw.

**d. Combined aggregate gradation.** This specification is targeted for a combined aggregate gradation developed following the guidance presented in United States Air Force Engineering Technical Letter (ETL) 97-5: Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements. Base the aggregate grading upon a combination of all the aggregates (coarse and fine) to be used for the mixture proportioning. Three aggregate sizes may be required to achieve an optimized combined gradation that will produce a workable concrete mixture for its intended use. Use aggregate gradations that produce concrete mixtures with well-graded or optimized aggregate combinations. The Contractor shall submit complete mixture information necessary to calculate the volumetric components of the mixture. The combined aggregate grading shall meet the following requirements:

(1) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in paragraph 501-2.1d(4) below, the point thus determined shall fall within the parallelogram described therein.

(2) The CF shall be determined from the following equation:

$$CF = \frac{\text{(cumulative percent retained on the 3/8 in. (9.5 mm) sieve)}(100)}{\text{(cumulative percent retained on the No. 8 (2.36 mm) sieve)}}$$

(3) The WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).

(4) A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary. The point determined by the plotting of the CF and WF may be adjusted during production  $\pm 3$  WF and  $\pm 5$  CF. Adjustments to gradation may not take the point outside of the parallelogram.

**e. Contractors combined aggregate gradation.** The Contractor shall submit their combined aggregate gradation using the following format:

**Contractor's Combined Aggregate Gradation**

Sieve Size	Contractor's Concrete mix Gradation (Percent passing by weight)
2 inch (50 mm)	*
1-1/2 inch (37.5 mm)	*
1 inch (25.0 mm)	*
3/4 inch (19.0 mm)	*
1/2 inch (12.5 mm)	*
3/8 inch (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 16 (1.18 mm)	*
No. 30 (600 $\mu$ m)	*
No. 50 (300 $\mu$ m)	*
No. 100 (150 $\mu$ m)	*

**501-2.2 Cement.** Cement shall conform to the requirements of ASTM C150 Type I, II, or V or ASTM C595 Type IP or IL.

**501-2.3 Cementitious materials.**

**a. Fly ash.** Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total alkali content less than 3% per ASTM C311. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as

they become available during the project. The reports can be used for acceptance or the material may be tested independently by the DEN Project Manager (DEN PM).

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

**c. Raw or calcined natural pozzolan.** Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

**501-2.4 Joint seal.** The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-604 and Item P-605, whichever is applicable, and shall be of the type specified in the plans.

**501-2.5 Isolation joint filler.** Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1751 or ASTM D1752 and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the DEN PM. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the DEN PM.

**501-2.6 Steel reinforcement.** Reinforcing shall consist of epoxy-coated steel wire and welded wire reinforcement conforming to the requirements of ASTM A884. Welded wire fabrics shall be furnished in flat sheets only..

**501-2.7 Dowel and tie bars.** Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete.

**a. Dowel Bars.** Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078, Type 1, with a coating thickness after curing greater than 10 mils. Patched ends are not required for Type 1 coated dowels. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

**b. Tie Bars.** Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

**501-2.8 Water.** Water used in mixing or curing shall be potable. If water is taken from other sources considered non-potable, it shall meet the requirements of ASTM C1602.

**501-2.9 Material for curing concrete.** Curing materials shall conform to one of the following specifications:

**a.** Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class A, or Class B.

**b.** White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

**c.** White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

**d.** Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

**501-2.10 Admixtures.** Admixtures shall conform to the following specifications:

**a. Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entraining agent and any water reducer admixture shall be compatible.

**b. Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D.

**c. Other admixtures.** The use of set retarding and set-accelerating admixtures shall be approved by the DEN PM prior to developing the concrete mix. Retarding admixtures shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating admixtures shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

**d. Lithium Nitrate.** The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

**Lithium Admixture**

Constituent	Limit (Percent by Mass)
LiNO <sub>3</sub> (Lithium Nitrate)	30 ±0.5
SO <sub>4</sub> (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium nitrate admixture dispensing and mixing operations shall be verified and certified by the lithium manufacturer's representative.

**501-2.11 Epoxy-resin.** All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

**a.** Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

**b.** Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

**c.** Material for use for injecting cracks shall be Type IV, Grade 1.

**d.** Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

**501-2.12 Bond Breaker.** Fabric shall meet the requirements of AASHTO M 288 Class I fabric with elongation not less than 50% at the specified strengths, with a weight not less than 14.5 oz/sy. A certificate of compliance (COC) shall be provided by the fabric manufacturer that the material may be used as a bond breaker.

## CONCRETE MIX

**501-3.1. General.** No concrete shall be placed until an acceptable concrete mix has been submitted to the DEN PM for review and the DEN PM has taken appropriate action. The DEN PM's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

**501-3.2 Concrete Mix Laboratory.** The laboratory used to develop the concrete mix shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix must be included in the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the DEN PM prior to start of construction.

**501-3.3 Concrete Mix Proportions.** Develop the mix using the procedures contained in Portland Cement Association (PCA) publication, "Design and Control of Concrete Mixtures." Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-6.6 for a flexural strength of **700 psi** per ASTM C78.

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be **517 pounds per cubic yard**. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be between 0.38 – 0.45 by weight.

Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. At the start of the project, the Contractor shall determine an allowable slump as determined by ASTM C143 not to exceed 2 inches (50 mm) for slip-form placement. For fixed-form placement, the slump shall not exceed 3 inches (75 mm). For hand placement, the slump shall not exceed 4 inches (100 mm).

The results of the concrete mix shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

If a change in source(s) is made, or admixtures added or deleted from the mix, a new concrete mix must be submitted to the DEN PM for approval.

The DEN PM may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

**501-3.4 Concrete Mix submittal.** The concrete mix shall be submitted to the DEN PM at least 30 days prior to the start of operations. The submitted concrete mix shall not be more than 180 days old and must use the materials to be used for production for the project. Production shall not begin until the concrete mix is approved in writing by the DEN PM.

Each of the submitted concrete mixes (i.e, slip form, side form machine finish and side form hand finish) shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items and quantities as a minimum:

- Certified material test reports for aggregate in accordance with paragraph 501-2.1. Certified reports must include all tests required; reporting each test, test method, test result, and requirement specified (criteria).
- Combined aggregate gradations and analysis; and including plots of the fine aggregate fineness modulus.
- Reactivity Test Results.
- Coarse aggregate quality test results, including deleterious materials.
- Fine aggregate quality test results, including deleterious materials.
- Mill certificates for cement and supplemental cementitious materials.
- Certified test results for all admixtures, including Lithium Nitrate if applicable.
- Specified flexural strength, slump, and air content.
- Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
- Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- Correlation ratios for acceptance testing and Contractor QC testing, when applicable.
- Historical record of test results documenting production standard deviation, when applicable.

#### **501-3.5 Cementitious materials.**

**a. Fly ash.** When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight.

**c. Raw or calcined natural pozzolan.** Natural pozzolan may be used in the concrete mix. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

#### **501-3.6 Admixtures.**

**a. Air-entraining admixtures.** Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be **5.5%**. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

**b. Water-reducing admixtures.** Water-reducing admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the

specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

**c. Other admixtures.** Set controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

**d. Lithium nitrate.** Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10d.

## **CONSTRUCTION METHODS**

**501-4.1 Control Strip.** The control strip(s) shall be to the next planned joint after the initial 250 feet (75 m) of each type of pavement construction (slip-form pilot lane, slip-form fill-in lane, or fixed form). The Contractor shall demonstrate, in the presence of the DEN PM, that the materials, concrete mix, equipment, construction processes, and quality control processes meet the requirements of the specifications. The concrete mixture shall be extruded from the paver meeting the edge slump tolerance and with little or no finishing. Pilot, fill-in, and fixed-form control strips will be accepted separately. Minor adjustments to the mix design may be required to place an acceptable control strip. The production mix will be the adjusted mix design used to place the acceptable control strip. Upon acceptance of the control strip by the DEN PM, the Contractor must use the same equipment, materials, and construction methods for the remainder of concrete paving. Any adjustments to processes or materials must be approved in advance by the DEN PM. Acceptable control strips will meet edge slump tolerance and surface acceptable with little or no finishing, air content within action limits, strength equal or greater than requirements of P501-3.3. The control strip will be considered one lot for payment (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 501-8.1 using a lot pay factor equal to 100.

**501-4.2 Equipment.** The Contractor is responsible for the proper operation and maintenance of all equipment necessary for handling materials and performing all parts of the work to meet this specification.

**a. Plant and equipment.** The plant and mixing equipment shall conform to the requirements of ASTM C94 and/or ASTM C685. Each truck mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades. The truck mixers shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

Equipment for transferring and spreading concrete from the transporting equipment to the paving lane in front of the finishing equipment shall be provided. The equipment shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

**b. Finishing equipment.**

**(1) Slip-form.** The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements.

**(2) Fixed-form.** On projects requiring less than 10,000 cubic yards of concrete pavement or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with equipment specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the DEN PM. Hand screeding and float finishing may only be used on small irregular areas as allowed by the DEN PM.

**c. Vibrators.** Vibrator shall be the internal type. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation or voids. The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309R, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the DEN PM.

Hand held vibrators may only be used in irregular areas and shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

**d. Concrete saws.** The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

**e. Fixed forms.** Straight side fixed forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the DEN PM. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the DEN PM. The forms shall extend the full depth of the pavement section.

**501-4.3 Form setting.** Forms shall be set to line and grade as shown on the plans, sufficiently in advance of the concrete placement, to ensure continuous paving operation. Forms shall be set to withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the concrete placement.

**501-4.4 Base surface preparation prior to placement.** Any damage to the prepared base, subbase, and subgrade shall be corrected full depth by the Contractor prior to concrete placement. The underlying surface shall be entirely free of frost when concrete is placed. The prepared grade shall be moistened with water, without saturating, immediately ahead of

concrete placement to prevent rapid loss of moisture from concrete. Bond breaker shall be applied in accordance with 501-2.12.

**501-4.5 Handling, measuring, and batching material.** Aggregate stockpiles shall be constructed and managed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Store and maintain all aggregates at a uniform moisture content prior to use. A continuous supply of materials shall be provided to the work to ensure continuous placement.

A copy of the proposed batch ticket shall be submitted to the DEN Project Manager for approval. Batch tickets shall include as a minimum the information required in ASTM C94. Two copies of the batch tickets shall also be provided to the DEN Project Manager or his representative for each batch of concrete prior to unloading at the site.

**501-4.6 Mixing concrete.** The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are placed into the drum until the drum is emptied into the truck. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94 or ASTM C685.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is discharged from the truck should not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. In no case shall the temperature of the concrete when placed exceed 90°F (32°C). Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified is not exceeded.

**501-4.7 Weather Limitations on mixing and placing.** No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

**a. Cold weather.** Unless authorized in writing by the DEN PM, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

Curing during cold weather shall be in accordance with paragraph 501-4.13d.

**b. Hot weather.** During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The concrete placement shall be protected from exceeding an evaporation rate of 0.2 psf (0.98 kg/m<sup>2</sup> per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. If the Contractor's measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

Curing during hot weather shall be in accordance with paragraph 501-4.13e.

**c. Temperature management program.** Prior to the start of paving operation for each day of paving, the Contractor shall provide the DEN PM with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. (Federal Highway Administration HIPERPAV 3 is one example of a temperature management program.) As a minimum, the program shall address the following items:

(1) Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

(2) Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 19-9, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

**d. Rain.** The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

**501-4.8 Concrete Placement.** At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi, based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. The Contractor must determine that the above minimum strengths are adequate to protection the pavement from overloads due to the construction equipment proposed for the project.

**a. Slip-form construction.** The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without, segregation, voids, or vibrator trails and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude should be adjusted proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

Not more than 15% of the total free edge of each 500-foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge.

When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump will be removed the full width of the slip form lane and replaced at the expense of the Contractor as directed by the DEN PM.

**b. Fixed-form construction.** Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars / dowel bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and coated with a release agent each time they are used and before concrete is placed against them.

Concrete shall be spread, screed, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery. The equipment must be specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the DEN PM.

Concrete for the full paving width shall be effectively consolidated by internal vibrators. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation, voids, or leaving vibrator trails.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

**c. Consolidation.** Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 2 inches (50 mm). Vibrators shall not be used to transport or spread the concrete. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) or over-consolidation (vibrator trails, segregation, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the DEN PM.

If a lack of consolidation of the hardened concrete is suspected by the DEN PM, referee testing may be required. Referee testing of hardened concrete will be performed by the DEN PM by cutting cores from the finished pavement after a minimum of 24 hours curing. The DEN PM shall visually examine the cores for evidence of lack of consolidation. Density determinations will be made by the DEN PM based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m<sup>2</sup>) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original concrete mix density, with no cores having a density of less than 96% of the original concrete mix density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the

effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

**501-4.9 Strike-off of concrete and placement of reinforcement.** Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screed. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

**501-4.10 Joints.** Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2-inch (12 mm) from their designated position and shall be true to line with not more than 1/4-inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12-foot (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

**a. Construction.** Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

**b. Contraction.** Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

**c. Isolation (expansion).** Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width

of the slab at the joint. The filler shall be fastened uniformly along the hardened joint face with no buckling or debris between the filler and the concrete interface, including a temporary filler for the sealant reservoir at the top of the slab. The edges of the joint shall be finished and tooled while the concrete is still plastic

#### **d. Dowels and Tie Bars for Joints**

**(1) Tie bars.** Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth and within the tolerances in paragraph 501-4.10(f.). When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.

**(2) Dowel bars.** Dowel bars shall be placed across joints in the proper horizontal and vertical alignment as shown on the plans. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the DEN PM. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

**(3) Placing dowels and tie bars.** Horizontal spacing of dowels shall be within a tolerance of  $\pm 3/4$  inch (19 mm). The vertical location on the face of the slab shall be within a tolerance of  $\pm 1/2$  inch (12 mm). The method used to install dowels shall ensure that the horizontal and vertical alignment will not be greater than  $1/4$  inch per feet (6 mm per 0.3 m), except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

**(a) Contraction joints.** Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

At the Contractor's option, dowels and tie bars in contraction joints may be installed by insertion into the plastic concrete using approved equipment and procedures per the paver manufacturer's design. Approval of installation methods will be based on the results of the control strip showing that the dowels and tie bars are installed within specified tolerances as verified by cores or non-destructive rebar location devices approved by the DEN PM.

**(b) Construction joints.** Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms.

**(c) Joints in hardened concrete.** Install dowels in hardened concrete by bonding the dowels into holes drilled into the concrete. The concrete shall have cured for seven (7) days or reached a minimum flexural strength of 450 psi before drilling begins. Holes  $1/8$  inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does

not occur. Spalling beyond the limits of the grout retention ring will require modification of the equipment and operation. Depth of dowel hole shall be within a tolerance of  $\pm 1/2$  inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole by means of a suitable metal or plastic grout retention ring fitted around the dowel.

**e. Sawing of joints.** Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial saw-cut and maintained for the remaining cure period.

Joints shall be cut in locations as shown on the plans. The initial joint cut shall be a minimum  $1/8$  inch (3 mm) wide and to the depth shown on the plans. Prior to placement of joint sealant or seals, the top of the joint shall be widened by sawing as shown on the plans.

**501-4.11 Finishing.** Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, edging of joints, and then texturing. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Equipment, mixture, and/or procedures which produce more than  $1/4$  inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way. Fog (mist) sprays or other surface applied finishing aids specified to prevent plastic shrinkage cracking, approved by the DEN PM, may be used in accordance with the manufacturers requirements.

**a. Machine finishing with slipform pavers.** The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. Equipment, mixture, and/or procedures which produce more than  $1/4$  inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Remove excessive slurry from the surface with a cutting straightedge and wipe off the edge. Any slurry which does run down the vertical edges shall be immediately removed by hand, using

stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

**b. Machine finishing with fixed forms.** The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

**c. Other types of finishing equipment.** Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the DEN PM's approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

**d. Hand finishing.** Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical.

**e. Straightedge testing and surface correction.** After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a 12-foot (3.7-m) finishing straightedge swung from handles capable of spanning at least one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

**501-4.12 Surface texture.** The surface of the pavement shall be finished as designated below for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. The texture shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the DEN PM.

**a. Brush or broom finish.** If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 inch in depth.

**b. Burlap drag finish.** If a burlap drag is used to texture the pavement surface, the burlap of at least 15 ounces per square yard will typically produce acceptable texture. To obtain a

textured surface, the transverse threads of the burlap shall be removed approximately one foot from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface.

**c. Artificial turf finish.** Not used.

**501-4.13 Curing.** Immediately after finishing operations are completed and bleed water is gone from the surface, all exposed surfaces of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-saw-cut method is used to construct the contraction joint, the curing compound shall be applied to the saw-cut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

**a. Impervious membrane method.** Curing with liquid membrane compounds should not occur until bleed and surface moisture has evaporated. All exposed surfaces of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 square feet (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the DEN PM, a double application rate shall be used to ensure coverage. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

**b. White burlap-polyethylene sheets.** The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

**c. Water method.** The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

**d. Concrete protection for cold weather.** Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for

the remainder of the 7-day curing period. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

**e. Concrete protection for hot weather.** Concrete should be continuous moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the DEN PM.

**501-4.14 Removing forms.** Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured in accordance with paragraph 501-4.13.

If honeycombed areas are evident when the forms are removed, materials, placement, and consolidation methods must be reviewed and appropriate adjustments made to assure adequate consolidation at the edges of future concrete placements. Honeycombed areas that extend into the slab less than approximately 1 inch (25 mm), shall be repaired with an approved grout, as directed by the DEN PM. Honeycombed areas that extend into the slab greater than a depth of 1 inch (25 mm) shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-4.19.

**501-4.15 Saw-cut grooving.** If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

**501-4.16 Sealing joints.** The joints in the pavement shall be sealed in accordance with Item P-604, P-604A and P-605.

**501-4.17 Protection of pavement.** The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until accepted by the DEN PM. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the DEN PM.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days, the joints are protected, the concrete has attained a minimum field cured flexural strength of 450 psi, and the slab edge is protected.

All new and existing pavement carrying construction traffic or equipment shall be kept clean and spillage of concrete and other materials shall be cleaned up immediately.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

**501-4.18 Opening to construction traffic.** The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural

strength of 450 pounds per square inch when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

**501-4.19 Repair, removal, or replacement of slabs.** New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable as defined by acceptance criteria in paragraph 501-6.6 shall be removed and replaced or repaired, as directed by the DEN PM, at the Contractor's expense. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The DEN PM will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall have a diameter of 2 inches (50 mm) to 4 inches (100 mm), shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with a bonding agent, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. Repair of cracks as described in this section shall not be allowed if in the opinion of the DEN PM the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

**a. Shrinkage cracks.** Shrinkage cracks which do not exceed one-third of the pavement depth shall be cleaned and either high molecular weight methacrylate (HMWM) applied; or epoxy resin (Type IV, Grade 1) pressure injected using procedures recommended by the manufacturer and approved by the DEN PM. Sandblasting of the surface may be required following the application of HMWM to restore skid resistance. Care shall be taken to ensure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the DEN PM. Shrinkage cracks which exceed one-third the pavement depth shall be treated as full depth cracks in accordance with paragraphs 501-4.19b and 501-19c.

**b. Slabs with cracks through interior areas.** Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than one-third the pavement depth, that extend into the interior area.

**c. Cracks close to and parallel to joints.** All full-depth cracks within 6 inches (150 mm) either side of the joint and essentially parallel to the original joints, shall be treated as follows.

**(1) Full depth cracks and original joint not cracked.** The full-depth crack shall be treated as the new joint and the original joint filled with an epoxy resin.

**i. Full-depth crack.** The joint sealant reservoir for the crack shall be formed by sawing to a depth of 3/4 inches (19 mm),  $\pm 1/16$  inch (2 mm), and to a width of 5/8 inch (16 mm),  $\pm 1/8$  inch (3 mm). The crack shall be sawed with equipment specially designed to follow random cracks. Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent raveling or spalling. The joint shall be sealed with sealant in accordance with P-605 or as directed by the DEN PM.

**ii. Original joint.** If the original joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures.

Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

**(2) Full depth cracks and original joint cracked.** If there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced.

**d. Removal and replacement of full slabs.** Make a full depth cut perpendicular to the slab surface along all edges of the slab with a concrete saw cutting any dowels or tie-bars. Remove damaged slab protecting adjacent pavement from damage. Damage to adjacent slabs may result in removal of additional slabs as directed by the DEN PM at the Contractor's expense.

The underlying material shall be repaired, re-compacted and shaped to grade.

Dowels of the size and spacing specified for other joints in similar pavement on the project shall be installed along all four (4) edges of the new slab in accordance with paragraph 501-4.10d.

Placement of concrete shall be as specified for original construction. The joints around the new slab shall be prepared and sealed as specified for original construction.

**e. Spalls along joints.** Spalls along joints are for new or existing pavements.

**(1)** Spalls less than one inch wide and less than the depth of the joint sealant reservoir, shall be filled with joint sealant material.

**(2)** Spalls larger than one inch and/or deeper than the joint reservoir, but less than ½ the slab depth, and less than 25% of the length of the adjacent joint shall be repaired as follows:

i. Make a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inches (50 mm). Saw cuts shall be straight lines forming rectangular areas surrounding the spalled area.

ii. Remove unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete between the saw cut and the joint or crack with a light chipping hammer.

iii. Clean cavity with high-pressure water jets supplemented with compressed air as needed to remove all loose material.

iv. Apply a prime coat of epoxy resin, Type III, Grade I, to the dry, cleaned surface of all sides and bottom of the cavity, except any joint face.

v. Fill the cavity with low slump concrete or mortar or with epoxy resin concrete or mortar.

vi. An insert or other bond-breaking medium shall be used to prevent bond at all joint faces.

vii. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints.

**(3)** Spalls deeper than 1/2 of the slab depth or spalls longer than 25% of the adjacent joint require replacement of the entire slab.

**f. Diamond grinding of Concrete surfaces.** Diamond grinding shall be completed prior to pavement grooving. Diamond grinding of the hardened concrete should not be performed until the concrete is at least 14 days old and has achieved full minimum strength. Equipment that

causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified.

Diamond grinding shall be performed with a machine specifically designed for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with sufficient number of flush cut blades that create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The Contractor shall determine the number and type of blades based on the hardness of the aggregate. Contractor shall demonstrate to the DEN PM that the grinding equipment will produce satisfactory results prior to making corrections to surfaces.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. All grinding shall be at the expense of the Contractor.

### **CONTRACTOR QUALITY CONTROL (CQC)**

**501-5.1 Quality control program.** The Contractor shall develop a Quality Control Program in accordance with Item C-100. No partial payment will be made for materials that are subject to specific quality control requirements without an approved quality control program.

**501-5.2 Contractor Quality Control (CQC).** The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The DEN PM shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The DEN PM will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

**501-5.3 Contractor QC testing.** The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to this specification and as set forth in the CQCP. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content. A QC Testing Plan shall be developed and approved by the DEN PM as part of the CQCP.

The DEN PM may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the DEN PM, and if it can be demonstrated in the laboratory, in the presence of the DEN PM, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

#### **a. Fine aggregate.**

**(1) Gradation.** A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

**(2) Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

**(3) Deleterious substances.** Fine aggregate as delivered to the mixer shall be tested for deleterious substances in fine aggregate for concrete as specified in paragraph 501-2.1b, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

**b. Coarse Aggregate.**

**(1) Gradation.** A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

**(2) Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

**(3) Deleterious substances.** Coarse aggregate as delivered to the mixer shall be tested for deleterious substances in coarse aggregate for concrete as specified in paragraph 501-2.1c, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

**c. Slump.** One test shall be made for each subplot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

**d. Air content.** One test shall be made for each subplot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

**e. Unit weight and Yield.** One test shall be made for each subplot. Unit weight and yield tests shall be in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

**f. Temperatures.** Temperatures shall be checked at least four times per lot at the job site in accordance with ASTM C1064.

**g. Smoothness for Contractor Quality Control.**

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the DEN PM. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the

two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, or FHWA profile program ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

**(1) Transverse measurements.** Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the DEN PM. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

**(2) Longitudinal measurements.** Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously placed material the first measurement shall start with one half length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 501-4.19f or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 501-6.6.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

**h. Grade.** Grade will be evaluated prior to and after placement of the concrete surface.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 0.04 feet vertically and 0.1 feet laterally. The documentation will be provided by the Contractor to the DEN PM by the end of the following working day.

Areas with humps or depression that exceed grade or smoothness and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. If these areas cannot be corrected with grinding then the slabs that are retaining water must be removed and replaced in accordance with paragraph 501-4.19d. Grinding shall be in accordance with paragraph 501-4.19f. All corrections will be at the Contractors expense.

**501-5.4 Control charts.** The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content. The Contractor shall also maintain a control chart plotting the coarseness factor/workability factor from the combined gradations in accordance with paragraph 501-2.1d.

Control charts shall be posted in a location satisfactory to the DEN PM and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the DEN PM may halt production or acceptance of the material.

**a. Fine and coarse aggregate gradation.** The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Superimposed on the control charts shall be the action and suspension limits. Gradation tests shall be performed by the Contractor per ASTM C136. The Contractor shall take at least two samples per lot to check the final gradation. Sampling shall be per ASTM D75 from the flowing aggregate stream or conveyor belt.

**b. Slump and air content.** The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

**c. Combined gradation.** The Contractor shall maintain a control chart plotting the coarseness factor and workability factor on a chart in accordance with paragraph 501-2.1d.

#### Control Chart Limits<sup>1</sup>

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Gradation <sup>2</sup>	*3	*3
Coarseness Factor (CF)	±3.5	±5
Workability Factor (WF)	±2	±3
Slump	+0.5 to -1 inch (+13 to -25 mm)	+1 to -1.5 inch (+25 to -38 mm)
Air Content	±1.5%	±2.0%

<sup>1</sup> Control charts shall developed and maintained for each control parameter indicated.

<sup>2</sup> Control charts shall be developed and maintained for each sieve size.

<sup>3</sup> Action and suspension limits shall be determined by the Contractor.

**501-5.5 Corrective action at Suspension Limit.** The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of control. The CQCP shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

- a. Fine and coarse aggregate gradation.** When two consecutive averages of five tests are outside of the suspension limits, immediate steps, including a halt to production, shall be taken to correct the grading.

b. Coarseness and Workability factor. When the CF or WF reaches the applicable suspension limits, the Contractor, immediate steps, including a halt to production, shall be taken to correct the CF and WF.

c. Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher shall be adjusted.

d. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

d. Air content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

## **MATERIAL ACCEPTANCE**

**501-6.1 Quality Assurance (QA) Acceptance sampling and testing.** All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the DEN PM representatives. DEN QA will provide the facilities for the curing of beams for acceptance testing. The Contractor shall bear the cost of coring and filling operations, per paragraph 501-6.5b(1).

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

**501-6.2 Quality Assurance (QA) testing laboratory.** Quality assurance testing organizations performing these acceptance tests will be accredited in accordance with ASTM C1077. The quality assurance laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods will be submitted to the DEN PM prior to start of construction.

**501-6.3 Lot size.** Concrete will be accepted for strength and thickness on a lot basis. A lot will consist of a day's production not to exceed **4,000** square yards. Each lot will be divided into approximately equal sublots with individual sublots between 400 to 600 cubic yards. Where three sublots are produced, they will constitute a lot. Where one or two sublots are produced, they will be incorporated into the previous or next lot. Where more than one plant is simultaneously producing concrete for the job, the lot sizes will apply separately for each plant.

**501-6.4 Partial lots.** When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot or for overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they will constitute a lot. Where one or two sublots have been produced, they will be incorporated into the next lot or the previous lot and the total number of sublots will be used in the acceptance criteria calculation, that is,  $n=5$  or  $n=6$ .

**501-6.5 Acceptance Sampling and Testing.**

**a. Strength.**

**(1) Sampling.** One sample will be taken for each subplot from the concrete delivered to the job site. Sampling locations will be determined by the DEN PM in accordance with random sampling procedures contained in ASTM D3665. The concrete will be sampled in accordance with ASTM C172.

**(2) Test Specimens.** The DEN PM will be responsible for the casting, initial curing, transportation, and curing of specimens in accordance with ASTM C31. Three (3) specimens will be made from each sample and slump, air content, unit weight, and temperature tests will be conducted for each set of strength specimens. Within 24 to 48 hours, the samples will be transported from the field to the laboratory while in the molds. Samples will be cured in saturated lime water.

The strength of each specimen will be determined in accordance with ASTM C78. The strength for each subplot will be computed by averaging the results of the two test specimens representing that subplot.

**(3) Acceptance.** Acceptance of pavement for strength will be determined by the DEN PM in accordance with paragraph 501-6.6b(1). All individual strength tests within a lot will be checked for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and the remaining test values will be used to determine acceptance in accordance with paragraph 501-6.5b.

**b. Pavement thickness.**

**(1) Sampling.** One core will be taken by the Contractor for each subplot in the presence of the DEN PM. Sampling locations will be determined by the DEN PM in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, will be excluded from sample locations.

Cores shall be a minimum 4 inch (100 mm) in diameter neatly cut with a core drill. The Contractor will furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes will be filled by the Contractor with a non-shrink grout approved by the DEN PM within one day after sampling.

**(2) Testing.** The thickness of the cores will be determined by the DEN PM by the average caliper measurement in accordance with ASTM C174. Each core shall be photographed and the photograph included with the test report.

**(3) Acceptance.** Acceptance of pavement for thickness will be determined by the DEN PM in accordance with paragraph 501-6.6.

**501-6.6 Acceptance criteria.**

**a. General.** Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-6.5b:

- (1) Strength
- (2) Thickness
- (3) Grade
- (4) Profilograph smoothness. Not used
- (5) Adjustments for repairs

Acceptance for strength, thickness, and grade, will be based on the criteria contained in accordance with paragraph 501-6.6b(1), 501-6.6b(2), and 501-6.6b(3), respectively.

Production quality must achieve 90 PWL or higher to receive full pavement.

Strength and thickness will be evaluated for acceptance on a lot basis using the method of estimating PWL. Production quality must achieve 90 PWL or higher to receive full pavement. The PWL will be determined in accordance with procedures specified in Item C-110.

The lower specification tolerance limit (L) for strength and thickness will be:

**Lower Specification Tolerance Limit (L)**

<b>Strength</b>	0.93 × strength specified in paragraph 501-3.3
<b>Thickness</b>	Lot Plan Thickness in inches, - 0.50 in

**b. Acceptance criteria.**

**(1) Strength.** If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 501-8.1.

**(2) Thickness.** If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 501-8.1.

**(3) Grade.** The final finished surface of the pavement of the completed project will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically and 0.1 feet laterally. The documentation, stamped and signed by a licensed surveyor shall be in accordance with paragraph 501-5.3h. Payment for sublots that do not meet grade for over 25% of the subplot shall be reduced by 5% and not be more than 95%.

**(4) Profilograph roughness for QA Acceptance.** Not used.

**(5) Adjustments for repair.** Sublots with spall repairs, crack repairs, or partial panel replacement, will be limited to no more than 95% payment.

**(6) Adjustment for grinding.** For sublots with grinding over 25% of a subplot, payment will be reduced 5%.

**METHOD OF MEASUREMENT**

**501-7.1** Concrete pavement shall be measured by the number of square yards of plain and reinforced pavement as specified in-place, completed and accepted. All dowels, reinforcement and additional concrete for thickened edges shall be considered incidental to the concrete pavement; no separate measurement or payment will be made for these items.

**501-7.2** Bond Breaker Fabric shall be measured by the number of square yards of materials placed and accepted by the DEN PM as complying with the plans and specifications excluding seam overlaps and edge anchoring.

### BASIS OF PAYMENT

**501-8.1 Payment.** Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 501-6.6. Acceptance Criteria shall be based on results of strength and thickness tests. Payment for acceptable lots of concrete pavement shall be adjusted in accordance with paragraph 501-8.1a for strength and thickness; 501-8.1b for repairs; 501-8.1c for grinding; and 501-8.1d for smoothness, subject to the limitation that:

The total project payment for concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of square yards of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings.

**a. Basis of adjusted payment.** The pay factor for each individual lot shall be calculated in accordance with the Price Adjustment Schedule table below. A pay factor shall be calculated for both strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both strength and thickness are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both strength and thickness are less than 100%.

#### Price Adjustment Schedule<sup>1</sup>

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject <sup>2</sup>

<sup>1</sup> Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% shall be subject to the total project payment limitation specified in paragraph 501-8.1.

<sup>2</sup> The lot shall be removed and replaced unless, after receipt of FAA concurrence, the Owner and Contractor agree in writing that the lot will remain; the lot paid at 50% of the contract unit price; and the total project payment limitation reduced by the amount withheld for that lot.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 501-8.1. Payment in excess of 100% for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100%; except for rejected lots which remain in place and/or sublots with adjustments for repairs.

**b. Adjusted payment for repairs.** The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots which contain repairs in accordance with paragraph 501-4.19 on more than 20% of the slabs within the sublot. Payment factors greater than 100 percent for the strength and thickness cannot be used to offset adjustments for repairs.

**c. Adjusted payment for grinding.** The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots with grinding over 25% of a subplot.

**d. Profilograph Roughness.** Not used.

- Item P-501-8.1** Portland Cement Concrete Pavement – 17” Non-Reinforced per square yard
- Item P-501-8.2** Portland Cement Concrete Pavement – 17” Reinforced per square yard
- Item P-501-8.3** Portland Cement Concrete Pavement – 9” Non-Reinforced per square yard
- Item P-501-8.4** Portland Cement Concrete Pavement – 9” Reinforced per square yard
- Item P-501-8.5** In-Pavement Light Blockout – per each
- Item P-501-8.6** Bond Breaker Fabric – per square yard

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

- ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
- ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- ASTM A704 Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
- ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars
- ASTM A884 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
- ASTM A934 Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
- ASTM A996 Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
- ASTM A1035 Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement
- ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- ASTM A1078 Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement

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ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

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ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064	Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

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ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface
American Concrete Institute (ACI)	
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
Advisory Circulars (AC)	
AC 150/5320-6	Airport Pavement Design and Evaluation
Federal Highway Administration (FHWA)	
HIPERPAV 3, version 3.2	
Portland Concrete Association (PCA)	
PCA	Design and Control of Concrete Mixtures, 16 <sup>th</sup> Edition
U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD)	
CRD C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)
United States Air Force Engineering Technical Letter (ETL)	
ETL 97-5	Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

END ITEM P-501

## Item P-603 Emulsified Asphalt Tack Coat

### DESCRIPTION

**603-1.1** This item shall consist of preparing and treating an asphalt or concrete surface with asphalt material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

### MATERIALS

**603-2.1 Asphalt materials.** The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the DEN Project Manager (DEN PM) before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

### CONSTRUCTION METHODS

**603-3.1 Weather limitations.** The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the DEN PM.

**603-3.2 Equipment.** The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the DEN PM.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

**603-3.3 Application of emulsified asphalt material.** The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the DEN PM prior to application.

#### Emulsified Asphalt

Surface Type	Residual Rate, gal/SY (L/square meter)	Emulsion Application Bar Rate, gal/SY (L/square meter)
New asphalt	0.02-0.05 (0.09-0.23)	0.03-0.07 (0.13-0.32)
Existing asphalt	0.04-0.07 (0.18-0.32)	0.06-0.11 (0.27-0.50)
Milled Surface	0.04-0.08 (0.18-0.36)	.06-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the DEN PM. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed. When the tack coat has been disturbed by the Contractor, tack coat shall be reapplied at the Contractor's expense.

**603-3.4 Freight and waybills** The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the DEN PM certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

#### METHOD OF MEASUREMENT

**603-4.1** The emulsified asphalt material for tack coat shall be measured by the gallon. Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas

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where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

### **BASIS OF PAYMENT**

**603.5-1** Payment shall be made at the contract unit price per gallon of emulsified asphalt material. This price shall be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-603-5.1          Emulsified Asphalt Tack Coat - per gallon

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

**END ITEM P-603**

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## ITEM P-604A PREFORMED EXPANSION JOINT COMPRESSION SEALS

### DESCRIPTION

**604A-1.1** This item shall consist of a moisture tight sealing system for structural sealing of expansion joints in concrete pavement. The seal shall consist of an impermeable closed-cell, closed link, ethylene vinyl acetate, low-density polyethylene copolymer, nitrogen blown resilient, non-extrudable foam material with a Ultraviolet (UV) stabilizer added.

### MATERIALS

**604A-2.1 GENERAL.** The material shall be meet the following physical requirements in Table 1. The material must be jet fuel resistant, glycol compatible, and include a UV stabilizer.

**Table 1. Physical Requirements**

Test	Test Method	Requirements
Compression Set	ASTM D3575 Suffix B	10% - 2 Hr Recovery 9% - 24 Hr Recovery
Elongation at break	ASTM D3575 Suffix T	185% - 280%
Tensile Strength	ASTM D3575 Suffix T	92 - 140 psi
Tear Resistance	ASTM D624	10-20 lbs/in
Density	ASTM D3575 Suffix W	2.7 -3.4 lbs/ft <sup>3</sup>
Water Absorption	ASTM D3575 Suffix L	0.02 lbs/ft <sup>2</sup>
Weather/Deterioration	AASHTO T42	No Deterioration

**604A-2.2 ADHESIVE.** Adhesive used for the preformed foam compression seal shall be as recommended by the manufacturer.

**604A-2.3 DELIVERY AND STORAGE.** Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided at the job site to protect materials from weather and to maintain them at temperatures as recommended by the manufacturer.

**604A-2.4 SUBMITTALS.** Certified copies of test results shall be provided in accordance with Section 013300 Submittal Procedures and 013325 Shop and Working Drawings, Product Data and Samples.

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**a. Construction Equipment List.** List of proposed equipment to be used in the performance of construction work, including descriptive data, shall be provided in accordance with Section 013300 and Section 013325.

**b. Manufacturer's Instructions.** Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of the recommendations shall be furnished in accordance with Section 013300 and Section 013325. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be a cause for rejection of the material.

**c. Test Reports/Samples.** The Contractor shall submit certified copies of the test reports and samples of the materials for approval in accordance with Section 013300 and Section 013325. Printed directions from the manufacturer on recommended installation criteria shall be furnished with the test reports, plus the manufacturer's certification that the selected seal is recommend for the installation on this project. No material will be used until it has been approved by the DEN Project Manager.

### **EQUIPMENT**

**604A-3.1** Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

**a. Joint Cleaning Equipment:**

**(1) Concrete Saw.** A self-propelled power saw with water cooled diamond or abrasive saw blades shall be provided for cutting joints to the depths and widths specified and for removing filler (existing old joint seal) or other material embedded in the joints or adhered to the joint faces.

**(2) Sandblasting Equipment.** Sandblasting shall not be permitted.

**(3) Water blasting Equipment.** Water blasting equipment shall include a trailer mounted water tank, pumps, high pressure hose, and a wand with safety release cutoff controls, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary water resupply equipment shall be sufficient capacity to permit continuous operations. The pumps, hoses, wand, and nozzle shall be of sufficient capacity to permit the cleaning of both walls of the joint and the pavement surface for a width of at least 1/2 inch on either side of the joint. The pump shall be capable of supplying a pressure of at least 3,000 psi. A pressure gauge mounted at the pump shall show at all times the pressure in pounds per square inch at which the equipment is operating.

### **CONSTRUCTION METHODS**

**604A-4.1 GENERAL.** Installation of foam joint sealant shall comply with Manufacturer's instructions and recommendations for foam joint sealant installation complete with a compatible epoxy adhesive for adhesion to all surfaces.

Prior to installing foam joint sealant, make certain that surfaces to which adhesive will adhere are clean and free of dust, dirt and other residues that would inhibit a proper bond.

The Contractor shall make arrangements for the Manufacturer's representative to meet with the Contractor and the DEN Project Manager prior to the start of sealing operations to ensure the installation procedures are in accordance with the Manufacturer's direction. A representative of the joint sealant manufacturer shall visit the job-site a sufficient number of times during the sealing operations and after the sealing is completed to certify that the joint sealant was installed in accordance with the manufacturer's recommended methods and procedures

**604A-4.2 PREPARATION OF JOINTS.** Immediately before installation of the preformed joint seal, the joints shall be thoroughly cleaned full depth to remove all laitance, filler, old existing sealant, foreign material and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Any irregularity in the joint face, which would prevent uniform contact between the joint seal and the joint face shall be corrected prior to the installation of the joint seal. All joint faces shall be vertical.

**a. Sawing.** Joints shall be sawed to clean and to open them to the full specified width and depth. Immediately following the sawing operation, the joint faces and opening shall be thoroughly cleaned using a water jet to remove all saw cuttings or debris remaining on the faces or in the joint opening. Compression seal shall be installed within 3 calendar days of the time the individual joint cavity is sawed. Depth of sawing the cavity shall be between  $\frac{3}{4}$  and 1 inch deeper than the uncompressed depth of the seal, or otherwise recommended by the manufacturer. The saw cut for the joint seal cavity shall at all locations be centered over the joint line. The nominal width of the sawed joint seal cavity shall be as follows; the actual width shall be within a tolerance of plus or minus 1/16 inch or as noted in the details.

**b. Sandblast Cleaning.** Sandblasting shall not be permitted.

**c. Waterblast Cleaning.** The concrete joint faces and pavement surfaces extending at least 1/2 inch from the joint edges shall be water blasted clean. A multiple pass technique shall be used until the surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the adhesive to the concrete. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water. When waterblast cleaning is used, slurry residue must be removed to provide a relatively dust free concrete surface.

**d. Rate of Progress.** The stages of joint preparation which includes water blasting of the joint faces and air pressure cleaning of the joints shall be limited to only the linear footage of joint that can be sealed during the same workday.

**604A-4.3 TIME OF INSTALLATION.** Joints shall be sealed within 3 calendar days of sawing the joint seal cavity and immediately following concrete cure and the final cleaning of the joint walls. Open joints ready for sealing that cannot be sealed under the conditions specified herein shall be provided with an approved temporary seal to prevent infiltration of foreign material. When rain interrupts the sealing operations, the joints shall be washed, air pressure cleaned and allowed to dry prior to installing the lubricant/adhesive and preformed seal.

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**604A-4.4 CLEAN UP.** Prior to Substantial Completion, all unused materials shall be removed from the site, any adhesive on the pavement surface shall be removed, and the pavement shall be left in clean condition.

**604A-4.5 WARRANTY.** The Manufacturer shall provide a warranty on the materials furnished for a minimum of 5 years from the date of acceptance by the DEN Project Manager. The Contractor shall provide a warranty on the installation for a minimum of 5 years from the date of acceptance by the DEN Project Manager.

**QUALITY CONTROL**

**604-5.1 PROCEDURES.** Quality control provisions shall be provided during the joint cleaning process to prevent or correct improper equipment and cleaning techniques that damages the concrete in any manner. Cleaned joints shall be approved by the DEN Project Manager prior to installation of the adhesive and preformed joint seal.

**604-5.2 PRODUCT.** The joint sealing system (preformed seal) shall be inspected for proper rate of cure and bonding to the concrete, cuts, twists, nicks, and other deficiencies. Seals exhibiting any defects, at any time prior to final acceptance of the project, shall be removed from the joint, wasted, and replaced in a satisfactory manner.

**METHOD OF MEASUREMENT**

**604-6.1** There shall be no direct measurement or payment for Preformed Expansion Joint Compression Seals associated with new pavement construction. The work under this item shall be considered incidental to the project.

**BASIS OF PAYMENT**

**604-7.1** Preformed Expansion Joint Compression Seals associated with new pavement construction shall be considered incidental to the project. No payment shall be made for Preformed Expansion Joint Compression Seals.

**TESTING REQUIREMENTS**

AASHTO T42	Standard Specification for Preformed Expansion Joint Filler for Concrete Construction
ASTM D 6211	Test Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 3575 SUFFIX B	Flexible Cellular Materials Made from Olefin Polymers
ASTM D 3575 SUFFIX L	Flexible Cellular Materials Made from Olefin Polymers
ASTM D 3575 SUFFIX T	Flexible Cellular Materials Made from Olefin Polymers
ASTM D 3575 SUFFIX W	Flexible Cellular Materials Made from Olefin Polymers

**END OF ITEM P-604A**

## Item P-605 Joint Sealants for Pavements

### DESCRIPTION

**605-1.1** This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints in pavement; joints between different types of pavements; and cracks in existing pavement.

### MATERIALS

**605-2.1 Joint sealants.** Joint sealant materials shall meet the requirements of ASTM D5893 for concrete joints or ASTM D6690-Type II for joints between concrete and asphalt.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

**605-2.2 Backer rod.** The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant in accordance with ASTM D5249. The backer-rod material shall be  $25\% \pm 5\%$  larger in diameter than the nominal width of the joint.

**605-2.3 Bond breaking tapes.** Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material shall have a melting point at least  $5^{\circ}\text{F}$  ( $3^{\circ}\text{C}$ ) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

### CONSTRUCTION METHODS

**605-3.1 Time of application.** Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be  $50^{\circ}\text{F}$  ( $10^{\circ}\text{C}$ ) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

**605-3.2 Equipment.** Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 14 days prior to use on the project.

**a. Concrete saw.** Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified.

**b. Sandblasting equipment.** Sandblasting is not allowed.

**c. Hand tools.** Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.

**d. Cold-applied, single-component sealing equipment.** The equipment for installing ASTM D5893 single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

**605-3.3 Preparation of joints.** Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. The Contractor shall demonstrate, in the presence of the DEN PM, that the method cleans the joint and does not damage the joint.

**a. Sawing.** All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

**b. Sealing.** Immediately before sealing, the joints shall be thoroughly cleaned of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant and other foreign material from the sides and upper edges of the joint space to be sealed. Cleaning shall be accomplished by sandblasting or concrete saw as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm) from it. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.

**c. Backer Rod.** When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a backer rod in accordance with paragraph 605-2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.

**d. Bond-breaking tape.** Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-separating tape breaker in accordance with paragraph 605-2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

**605-3.4 Installation of sealants.** Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the DEN PM before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch  $\pm$ 1/16 inch below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be

permitted over newly sealed pavement until authorized by the DEN PM. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

**605-3.5 Inspection.** The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

**605-3.6 Clean-up.** Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

**605-3.7 FIELD TEST.** Before sealing the joints, the Contractor shall demonstrate that the equipment and procedures for preparing, mixing, and placing the sealant will produce a satisfactory joint seal. The demonstration shall include the preparation of at least two small batches and the application of the resulting material in five joints of at least 25 feet in length each. A representative of the joint sealant manufacturer shall be present at the demonstration to ensure that the installation procedures are in accordance with the manufacturer's recommended installation instructions.

a. Testing For Cold Applied Silicone Sealants. When checking for adhesions of silicone, a pull test may be performed on the job site 21 days after the sealant has been placed.

1. Make a knife cut horizontally across and through the silicone from one side of the joint to the other.
2. Make a vertical cut approximately 2-3 inches long on each side of the joint starting at the horizontal cut, keeping the cuts the same length on each side.
3. Hold the piece of silicone firmly and slowly pull at a 90° degree angle stretching the silicone not more than 10" per minute as if trying to pull the adhered silicone out of the joint.
4. If adhesion is proper, the silicone will not pull out of the joint, but will eventually tear cohesively across the joint at the base of the knife cut.

b. If the silicone releases from the joint, adhesion has been affected. Several possible causes are:

1. Moisture in the joint during sealant application
2. Dirty or dusty joint sidewalls
3. Improper application (overfilling, etc.)
4. Spalling of the joint walls. (pieces of the concrete will be adhered to the silicone)

c. Repair of Sealant In Areas of Adhesion Test. The silicone sealant may be replaced by simply applying additional new silicone (normally using a tube of like silicone) in the same manner as it was originally placed, providing good adhesion was achieved. Proper preparation of the area should be performed prior to reapplying the silicone assuring the original silicone and the newly applied silicone are in good contact with each other.

**605-3.8 WARRANTY.** The manufacturer shall provide a warranty on the materials furnished for a minimum of 1 year from the date of acceptance by the DEN Project Manager. The Contractor shall provide a warranty on the installation for a minimum of 1 year from the date of acceptance by the DEN Project Manager.

**METHOD OF MEASUREMENT AND BASIS OF PAYMENT**

**605-4.1** No separate measurement or payment will be made for sawing or joint sealing on new pavements. The cost for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item shall be included in the Contractor's price for pavement.

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASTM International (ASTM)

ASTM D789	Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)
ASTM D5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D5893	Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt

## Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
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**END ITEM P-605**

**Item P-606****Adhesive Compounds, Two-Component for Sealing Wire and Lights in Pavement****DESCRIPTION**

**606-1.1** This specification covers two types of material; a liquid suitable for sealing electrical wire in saw cuts in pavement and for sealing light fixtures or bases in pavement, and a paste suitable for embedding light fixtures in the pavement. Both types of material are two-component filled formulas with the characteristics specified in paragraph 606-2.4. Materials supplied for use with asphalt and/or concrete pavements must be formulated so they are compatible with the asphalt and/or concrete.

**MATERIALS**

**606-2.1 Curing.** When pre-warmed to 77°F (25°C), mixed, and placed in accordance with manufacturer's directions, the materials shall cure at temperatures of 45°F (7°C) or above without the application of external heat.

**606-2.2 Storage.** The adhesive components shall not be stored at temperatures over 86°F (30°C), unless otherwise specified by the manufacturer.

**606-2.3 Caution.** Installation and use shall be in accordance with the manufacturer's recommended procedures. Avoid prolonged or repeated contact with skin. In case of contact, wash with soap and flush with water. If taken internally, call doctor. Keep away from heat or flame. Avoid vapor. Use in well-ventilated areas. Keep in cool place. Keep away from children.

**606-2.4 Characteristics.** When mixed and cured in accordance with the manufacturer's directions, the materials shall have the following properties shown in Table 1.

**Table 1. Property Requirements**

Physical or Electrical Property	Minimum	Maximum	ASTM Method
<b>Tensile</b>			
Portland cement concrete	1,000 psi (70 kg/sq cm)		D 638
Asphalt concrete	500 psi (35 kg/sq cm)		
<b>Elongation</b>			
Portland cement concrete		See note <sup>1</sup>	D 638
Asphalt concrete	50%		D 638
Coef. of cub. exp. cu. cm/cu. cm/°C	0.00090	0.00120	D 1168
Coef. of lin. exp. cm/cm/°C	0.000030	0.000040	D 1168
Dielectric strength, short time test	350 volts/mil.		D 149
Arc resistance	125 sec		
<b>Pull-off</b>			
Adhesion to steel	1,000 psi (70 kg/sq cm)		
Adhesion to Portland cement concrete	200 psi (14 kg/sq cm)		
Adhesion to asphalt concrete	No test available.		
Adhesion to aluminum	250 psi		

<sup>1</sup> 20% or more (without filler) for formulations to be supplied for areas subject to freezing.

## SAMPLING, INSPECTION, AND TEST PROCEDURES

**606-3.1 Tensile properties.** Tests for tensile strength and elongation shall be conducted in accordance with ASTM D638.

**606-3.2 Expansion.** Tests for coefficients of linear and cubical expansion shall be conducted in accordance with, Method B, except that mercury shall be used instead of glycerine. The test specimen shall be mixed in the proportions specified by the manufacturer, and cured in a glass tub approximately 2 inch (50 mm) long by 3/8 inch (9 mm) in diameter. The interior of the tube shall be precoated with a silicone mold release agent. The hardened sample shall be removed from the tube and aged at room temperature for one (1) week before conducting the test. The test temperature range shall be from 35°F (2°C) to 140°F (60°C).

**606-3.3 Test for dielectric strength.** Test for dielectric strength shall be conducted in accordance with ASTM D149 for sealing compounds to be furnished for sealing electrical wires in pavement.

**606-3.4 Test for arc resistance.** Test for arc resistance shall be conducted for sealing compounds to be furnished for sealing electrical wires in pavement.

**606-3.5 Test for adhesion to steel.** The ends of two smooth, clean, steel specimens of convenient size (1 inch by 1 inch by 6 inch) (25 mm by 25 mm by 150 mm) would be satisfactory when bonded together with adhesive mixture and allowed to cure at room temperature for a period of time to meet formulation requirements and then tested to failure on a Riehle (or similar) tensile tester. The thickness of adhesive to be tested shall be 1/4 inch (6 mm).

**606-3.6 Adhesion to Portland cement concrete**

**a. Concrete test block preparation.** The aggregate grading shall be as shown in Table 2.

The coarse aggregate shall consist of crushed rock having a minimum of 75% of the particles with at least one fractured face and having a water absorption of not more than 1.5%. The fine aggregate shall consist of crushed sand manufactured from the same parent rock as the coarse aggregate. The concrete shall have a water-cement ratio of 5.5 gallons (21 liters) of water per bag of cement, a cement factor of 6,  $\pm 0.5$ , bags of cement per cubic yard (0.76 cubic meter) of concrete, and a slump of 2-1/2 inch (60 mm),  $\pm 1/2$  inch (60 mm  $\pm 12$  mm). The ratio of fine aggregate to total aggregate shall be approximately 40% by solid volume. The air content shall be 5.0%,  $\pm 0.5\%$ , and it shall be obtained by the addition to the batch of an air-entraining admixture such as Vinsol® resin. The mold shall be of metal and shall be provided with a metal base plate.

Means shall be provided for securing the base plate to the mold. The assembled mold and base plate shall be watertight and shall be oiled with mineral oil before use. The inside measurement of the mold shall be such that several one inch (25 mm) by 2-inch (75 mm) by 3-inch (25 mm by 50 mm by 75 mm) test blocks can be cut from the specimen with a concrete saw having a diamond blade. The concrete shall be prepared and cured in accordance with ASTM C192.

**Table 2. Aggregate for Bond Test Blocks**

Type	Sieve Size	Percent Passing
<b>Coarse Aggregate</b>	3/4 inch (19.0 mm)	97 to 100
	1/2 inch (12.5 mm)	63 to 69
	3/8 inch (9.5 mm)	30 to 36
	No. 4 (4.75 mm)	0 to 3
<b>Fine Aggregate</b>	No. 4 (4.75 mm)	100
	No. 8 (2.36 mm)	82 to 88
	No. 16 (1.18 mm)	60 to 70
	No. 30 (600 $\mu$ m)	40 to 50
	No. 50 (300 $\mu$ m)	16 to 26
	No. 100 (150 $\mu$ m)	5 to 9

**b. Bond test.** Prior to use, oven-dry the test blocks to constant weight at a temperature of 220°F to 230°F (104°C to 110°C), cool to room temperature, 73.4°F  $\pm 3$ °F (23°C  $\pm 1.6$ °C), in a desiccator, and clean the surface of the blocks of film or powder by vigorous brushing with a stiff-bristled fiber brush. Two test blocks shall be bonded together on the one inch by 3 inch (25 mm by 75 mm) sawed face with the adhesive mixture and allowed to cure at room temperature for a period of time to meet formulation requirements and then tested to failure in a Riehle (or similar) tensile tester. The thickness of the adhesive to be tested shall be 1/4 inch (6 mm).

TECHNICAL SPECIFICATIONS  
 DIVISION 2 – AIRFIELD STANDARDS  
 ITEM P-606 ADHESIVE COMPOUNDS, TWO-COMPONENT  
 FOR SEALING WIRE AND LIGHTS IN PAVEMENT

DENVER INTERNATIONAL AIRPORT  
 TAXIWAY DS EAST  
 CONTRACT NO. 201737642-02

**606-3.7 Compatibility with asphalt mix.** Test for compatibility with asphalt in accordance with ASTM D5329.

**606-3.8 Adhesive compounds - Contractor's responsibility.** The Contractor shall furnish the vendor's certified test reports for each batch of material delivered to the project. The report shall certify that the material meets specification requirements and is suitable for use with concrete or asphalt concrete pavements. The report shall be provided to and accepted by the DEN Project Manager( DEN PM) before use of the material. In addition, the Contractor shall obtain a statement from the supplier or manufacturer that guarantees the material for one year. The supplier or manufacturer shall furnish evidence that the material has performed satisfactorily on other projects.

**606-3.9 Application.** Adhesive shall be applied on a dry, clean surface, free of grease, dust, and other loose particles. The method of mixing and application shall be in strict accordance with the manufacturer's recommendations. When used with Item P-605, such as light can installation, Item P-605 shall not be applied until the Item P-606 has fully cured.

#### METHOD OF MEASUREMENT AND BASIS OF PAYMENT

**606-4.1** No separate measurement or payment will be made for adhesive compounds sealing wire lights in pavements. The cost for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item shall be included in the Contractor's price for lights in pavements.

#### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D5329	Standard Test Methods for Sealants and Fillers, Hot-applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements

**END OF ITEM P-606**

## Item P-610 Concrete for Miscellaneous Structures

### DESCRIPTION

**610-1.1** This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

### MATERIALS

**610-2.1 General.** Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the DEN Project Manager (DEN PM) before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

**a. Reactivity.** Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the DEN PM. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20% the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation; or aggregates that meet P-501 reactivity test requirements may be utilized.

**610-2.2 Coarse aggregate.** The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

### Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1 1/2 inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
¾ inch (19 mm)	67
½ inch (12.5 mm)	7

**610-2.2.1 Coarse Aggregate susceptibility to durability (D) cracking.** Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test requirements but must meet all other quality tests specified in Item P-501.

**610-2.3 Fine aggregate.** The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

**610-2.4 Cement.** Cement shall conform to the requirements of ASTM C150 Type V. Type I/II LA cement may be substituted for Type V cement, subject to DEN PM approval, should the Type I/II LA cement meet Type V requirements for sulfate resistance, deleterious activity, and total alkali content.

#### 610-2.5 Cementitious materials.

**a. Fly ash.** Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the DEN PM.

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

**610-2.6 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**610-2.7 Admixtures.** The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the DEN PM may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the DEN PM from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

**a. Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

**b. Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

**c. Other chemical admixtures.** The use of set retarding, and set-accelerating admixtures shall be approved by the DEN PM. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

**610-2.8 Premolded joint material.** Premolded joint material for expansion joints shall meet the requirements of ASTM D1751.

**610-2.9 Joint filler.** The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

**610-2.10 Steel reinforcement.** Reinforcing shall consist of Bar Mats conforming to the requirements of ASTM A184.

**610-2.11 Materials for curing concrete.** Curing materials shall conform to ASTM C309.

## **CONSTRUCTION METHODS**

**610-3.1 General.** The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the DEN PM.

**610-3.2 Concrete Mixture.** The concrete shall develop a compressive strength in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39.

- a. 4,500 psi for utility structure installation or adjustment.
- b. 4,000 psi for concrete encased lighting ducts and light cans.
- c. 1,200 psi at 7 days for the repair of cement treated base course.

The concrete shall contain not less than 615 – 660 pounds of cementitious material (cement plus fly ash) per cubic yard for 4,500 psi in 28 days, nor less than 470 pounds of cementitious material per cubic yard for 4,000 psi in 28 days, and as needed for 1,200 psi in 7 days. The concrete shall contain 6% of entrained air, +/-1.5%, as determined by ASTM C231 and shall have a slump of not more than 6 inches as determined by ASTM C143.

**610-3.3 Mixing.** Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the DEN PMs approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted unless Contractor obtains approval of DEN PM to follow ASTM C94, paragraph 12.7 for concrete delivered in truck mixer or truck agitator.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

**610-3.4 Forms.** Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the DEN PM. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

**610-3.5 Placing reinforcement.** All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

**610-3.6 Embedded items.** Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

**610-3.7 Concrete Consistency.** The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

**610-3.8 Placing concrete.** All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the DEN PM. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its

final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

**610-3.9 Vibration.** Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

**610-3.10 Joints.** Joints shall be constructed as indicated on the plans.

**610-3.11 Finishing.** All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

**610-3.12 Curing and protection.** All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

**610-3.13 Cold weather placing.** When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

**610-3.14 Hot weather placing.** When concrete is placed in hot weather greater than 85°F (30°C), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

## **QUALITY ASSURANCE (QA)**

**610-4.1 Quality Assurance sampling and testing.** Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The DEN PM will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

The first load of concrete, per mix, delivered each day will be sampled and tested.

Concrete placed for structures will be sampled and tested for each additional 50 cubic yards per day with a minimum one test per structure. When a single load of concrete is used for more than one structure, that load will be sampled and tested once.

Concrete placed for structures will be sampled and tested for each additional 50 cubic yards per day.

Lean concrete will be sampled and tested for each additional 50 cubic yards per day.

Concrete strengths for acceptance shall be the average of at least two 6 by 12 inch or at least three 4 by 8 inch cylinders tested at 28 days.

**610-4.2 Defective work.** Any defective work that cannot be satisfactorily repaired as determined by the DEN PM, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

### METHOD OF MEASUREMENT

**610-5.1** In general, and unless listed in the proposal as a separate payment item, structural concrete will not be measured for payment, but shall be incidental to those proposed items constructed of concrete.

**610-5.2** Cement-Treated Base Course Repair shall be measured per square yard including existing cement treated base milling and structural concrete installation.

### BASIS OF PAYMENT

**610-6.1** Structural concrete shall be considered incidental to the project. No payment shall be made for structural concrete, unless listed in the proposal as a separate payment item.

**610-6.2** Payment for Cement-Treated Base Course Repair shall be made at the contract price by the number of square yards. This price shall be full compensation for furnishing all materials including reinforcement and embedded items and for all preparation, delivery, installation, and curing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

**610-6.3** Payment shall be made at the contract price by the number of linear feet for existing DIW force main concrete encasement. This price shall be full compensation for furnishing all materials including reinforcement and embedded items and for all preparation, delivery, installation, and curing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-610-6.1	Cement-Treated Base Course Repair – per square yard
Item P-610-6.2	Existing DIW Force Main Concrete Encasement – per linear foot

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM P-610 CONCRETE FOR  
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ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement

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**TECHNICAL SPECIFICATIONS  
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ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

**American Concrete Institute (ACI)**

ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to External Curing of Concrete
ACI 309R	Guide for Consolidation of Concrete

**END OF ITEM P-610**

## Item P-620 Runway and Taxiway Marking

### DESCRIPTION

**620-1.1** This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the DEN Project Manager (DEN PM). The terms “paint” and “marking material” as well as “painting” and “application of markings” are interchangeable throughout this specification.

### MATERIALS

**620-2.1 Materials acceptance.** The Contractor shall furnish manufacturer’s certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer’s surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the DEN PM prior to the initial application of markings. The reports can be used for material acceptance or the DEN PM may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the DEN PM upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the DEN PM.

**620-2.2 Marking materials.**

**Table 1. Marking Materials**

Paint <sup>1</sup>				Glass Beads <sup>2</sup>	
Type	Color	Fed Std. 595 Number	Application Rate Maximum	Type	Application Rate Minimum
Waterborne Type I or II	Yellow	33538	115 ft <sup>2</sup> /gal	Type I, Gradation A	7 lb/gal
Waterborne Type I or II	Black	37038	115 ft <sup>2</sup> /gal	Not Used	Not Used
Methacrylate	Yellow	33538	45 ft <sup>2</sup> /gal	Type I, Gradation A	15 lb/gal
Methacrylate	Black	37038	45 ft <sup>2</sup> /gal	Not Used	Not Used

<sup>1</sup> See paragraph 620-2.2a

<sup>2</sup> See paragraph 620-2.2b

**a. Paint.** Paint shall be waterborne or methacrylate in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595.

**Waterborne.** Paint shall meet the requirements of Federal Specification TT-P-1952F, Type I or Type II. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis.

**Methacrylate.** Paint shall be a two component, minimum 99% solids-type system conforming to the following:

**(1) Pigments.** Component A. Percent by weight.

**(a) White:**

- Titanium Dioxide, ASTM D476, type II shall be 10% minimum.
- Methacrylate resin shall be 18% minimum.

**(b) Yellow and Colors:**

- Titanium Dioxide, ASTM D476, type II shall be 1% minimum.  
Organic yellow, other colors, and tinting as required to meet color standard.
- Methacrylate resin shall be 18% minimum.

**(2) Prohibited materials.** The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

**(3) Daylight directional reflectance:**

**(a) White:** The daylight directional reflectance of the white paint shall not be less than 80% (relative to magnesium oxide), when tested in accordance with ASTM E2302.

**(b) Yellow:** The daylight directional reflectance of the yellow paint shall not be less than 55% (relative to magnesium oxide), when tested in accordance with ASTM E2302. The x and y values shall be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x	.462	x	.470	x	.479	x	.501
y	.438	y	.455	y	.428	y	.452

**(4) Accelerated weathering.**

**(a) Sample preparation.** Apply the paint at a wet film thickness of 0.013-inch (0.33 mm) to four 3 × 6-inch (8 × 15 cm) aluminum panels prepared as described in ASTM E2302. Air dry the sample 48 hours under standard conditions.

**(b) Testing conditions.** Test in accordance with ASTM G154 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating four (4) hour UV exposure at 140°F (60°C), and four (4) hours condensate exposure at 104°F (40°C).

**(c) Evaluation.** Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 3 above. Evaluate for conformance with the color requirements.

**(5) Volatile organic content.** Determine the volatile organic content in accordance with 40 CFR Part 60 Appendix A, Method 24.

**(6) Dry opacity.** Use ASTM E2302. The wet film thickness shall be 0.015 inch (0.38 mm). The minimum opacity for white and colors shall be 0.92.

**(7) Abrasion resistance.** Subject the panels prepared in paragraph 620-2.2c(4) to the abrasion test in accordance with ASTM D968, Method A, except that the inside diameter of the metal guide tube shall be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters (17.5 lb (7.94 kg)) of unused sand shall be used for each test panel. The test shall be run on two test panels. Both baked and weathered paint films shall require not less than 150 liters (525 lbs (239 kg)) of sand for the removal of the paint films.

**(8) Hardness, shore.** Hardness shall be at least 60 when tested in accordance with ASTM D2240.

**(9) Additional requirements for methacrylate splatter profiled pavement marking.** Pavement markings of this type shall comply with all above requirements for methacrylate paint, except as noted below:

(a) The thickness of the marking will be irregular ranging from 0.000 to 0.250 inches (0.00 to 6.4 mm), applied in a splatter pattern which comprises a minimum of 80% of the visible line (when traveling at 5 mph the line appears to be solid.).

(b) The hardness shall be 48 Shore D minimum.

**b. Reflective media.** Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type I, Gradation A.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A.

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

## **CONSTRUCTION METHODS**

**620-3.1 Weather limitations.** Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

**620-3.2 Equipment.** Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

**620-3.3 Preparation of surfaces.** Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminants that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface

preparation shall be approved in advance by the DEN PM. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

**a. Preparation of new pavement surfaces.** The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the DEN PM to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

**b. Preparation of pavement to remove existing markings.** Existing pavement markings shall be removed by water blasting or by other methods approved by the DEN PM minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.

**c. Preparation of pavement markings prior to remarking.** Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the DEN PM. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the DEN PM prior to the initial application of markings.

**620-3.4 Layout of markings.** The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

**620-3.5 Application.** A period of 30 days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the DEN PM.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

#### Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing

glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

**620-3.6 Application--preformed thermoplastic airport pavement markings.** Preformed thermoplastic pavement markings not used.

**620-3.7 Control strip.** Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the DEN PM. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

**620-3.8 Retro-reflectance.** Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

#### Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m <sup>2</sup> /lux		
	White	Yellow	Red
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than <sup>1</sup>	100	75	10

<sup>1</sup> Prior to remarking determine if removal of contaminants on markings will restore retro-reflectance

**620-3.9 Protection and cleanup.** After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the DEN PM. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

#### METHOD OF MEASUREMENT

**620-4.1** The quantity of markings for shall be paid for shall be measured by the number of square feet of painting.

**620-4.2** The quantity of temporary markings to be paid for shall be the number of square feet of painting performed in accordance with the specifications and accepted by the DEN PM.

Temporary marking includes surface preparation, application and complete removal of the temporary marking.

**620-4.3** The quantity of stop signs, VSR delineators, and bollards to be paid for shall be per each in accordance with the drawings.

### BASIS OF PAYMENT

**620-5.1** This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the DEN PM in accordance with these specifications.

**620-5.2** Payment for markings shall be made at the contract price for the number of square feet of painting.

**620-5.3** Payment for temporary markings shall be made at the contract price for the number of square feet of painting. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

**620-5.4** Payment for stop signs, VSR delineators, and bollards shall be made at the contract unit price for the number of stop signs, VSR delineators, and bollards installed. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-620-5.1	Pavement Marking Removal – per square foot
Item P-620-5.2	Pavement Marking (Waterborne) – per square foot
Item P-620-5.3	Non-Reflective Pavement Marking (Waterborne) - per square foot
Item P-620-5.4	Pavement Marking (Methacrylate) – per square foot
Item P-620-5.5	Non-Reflective Pavement Marking (Methacrylate) – per square foot
Item P-620-5.6	Temporary Pavement Marking – per square foot
Item P-620-5.7	Stop Sign – per each
Item P-620-5.8	VSR Delineator – per each
Item P-620-5.9	Install Bollard – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
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ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2302	Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

## Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24  
Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

## Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D	Beads (Glass Spheres) Retro-Reflective
FED SPEC TT-P-1952F	Paint, Traffic and Airfield Marking, Waterborne
FED STD 595	Colors used in Government Procurement

## Advisory Circulars (AC)

AC 150/5340-1	Standards for Airport Markings
AC 150/5320-12	Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

**END OF ITEM P-620**

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## Item D-701 Pipe for Storm Drains and Culverts

### DESCRIPTION

**701-1.1** This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

### MATERIALS

**701-2.1** Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

**701-2.2 Pipe.** The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C1840	Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe

**701-2.3 Concrete.** Concrete for pipe cradles shall be in accordance with P-610.

**701-2.4 Rubber gaskets.** Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the "RE" closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

**701-2.5 Joint mortar.** Pipe joint mortar shall consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**701-2.6 Joint fillers.** Poured filler for joints shall conform to the requirements of ASTM D6690.

**701-2.7 Plastic gaskets.** Plastic gaskets shall conform to the requirements of ASTM C990.

**701-2.8. Controlled low-strength material (CLSM).** Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used, all joints shall have gaskets.

**701-2.9 Precast box culverts.** Not used.

**701-2.10 Precast concrete pipe.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association Cast Plant Certification program.

**701-2.11 Solvent Cement.** Solvent Cement shall conform to the requirements of Section 221316-2.2(l).

**701-2.12 Backwater Valve.** Denver water vault drain line backwater vales shall conform to the requirements of Division 22.

## CONSTRUCTION METHODS

**701-3.1 Excavation.** The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactorily jointing of the pipe and thorough compaction of the bedding material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade should be filled with granular material to form a uniform foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The DEN PM shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

In the event of ground water invasion of the trench, the contractor shall be responsible for all dewatering work as subsidiary to the contract pay items. There will be no additional payment for pumping, dewatering wells, over excavation, etc. due to ground water.

**701-3.2 Bedding.** The pipe bedding shall conform to the requirements of CDOT Standard Specifications for Class 4 aggregate base course (CDOT Table 703-2).

**a. Rigid pipe.** The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

**b. Flexible pipe.** For flexible pipe, the bedding material shall be in accordance with Item P-153.

**c. Other pipe materials.** For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

**701-3.3 Laying pipe.** The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

**701-3.4 Joining pipe.** Joints shall be made with (1) cement mortar, (2) cement grout, (3) rubber gaskets, (4) plastic gaskets, (5) coupling bands, or (6) solvent-cementing (plastic, non-pressure piping).

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

**a. Concrete pipe.** Concrete pipe may be either bell and spigot or tongue and groove. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Concrete pipe joints shall be sealed with rubber gaskets meeting ASTM C443 when leak resistant joints are required.

**b. Metal pipe.** Metal pipe shall be firmly joined by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

**c. PVC, Polyethylene, or Polypropylene pipe.** Joints for PVC, Polyethylene, or Polypropylene pipe shall conform to the requirements of ASTM D3212 when leak resistant joints are required. Joints for PVC and Polyethylene pipe shall conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M252 or ASTM M294. Fittings for polypropylene pipe shall conform to ASTM F2881, ASTM F2736, or ASTM F2764. Solvent-cemented plastic pipe joint materials and installation methods shall be in conformance with Section 221316.

**d. Fiberglass pipe.** Not used.

**701-3.5 Embedment and Overfill.** Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

#### **701-3.5-1 Embedment Material Requirements**

**a. Concrete Pipe.** Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM

C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

**b. Plastic Pipe.** Embedment material shall meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material shall be free of organic material, stones larger than 1.5 inches in the greatest dimension, or frozen lumps. Embedment material shall extend to 12 inches above the top of the pipe.

**c. Metal Pipe.** Embedment material shall be granular as specified in the contract document and specifications, and shall be free of organic material, rock fragments larger than 1.5 inches in the greatest dimension and frozen lumps. As a minimum, backfill materials shall meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material shall extend to 12 inches above the top of the pipe.

#### **701-3.5-2 Placement of Embedment Material**

The embedment material shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level, whichever is greater. Thoroughly compact the embedment material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under Item P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.

It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

#### **701-3.6 Overfill**

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be placed and compacted in layers as required to achieve compaction of at least 95 percent standard proctor per ASTM D698. The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

#### **701-3.7 Inspection Requirements**

An initial post installation inspection shall be performed by the DEN PM no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

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For pipe sizes larger than 48 inches, a walk-through visual inspection shall be performed.

Incorporate specific inspection requirements for the various types of pipes beneath the general inspection requirements.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm.

Flexible pipes shall be inspected for rips, tears, joint separations, soil migration, cracks, localized buckling, settlement, alignment, and deflection. Determine whether the allowable deflection has been exceeded by use of a laser profiler for internal pipe diameters of 48 inches or less, or direct measurement for internal pipe diameters greater than 48 inches. Laser profile equipment shall utilize low barrel distortion video equipment. Deflection of installed pipe shall not exceed the limits provided in the table below, as a percentage of the average inside diameter of the pipe.

Maximum Allowable Pipe Deflection

Type of Pipe	Maximum Allowable Deflection (%)
Corrugated Metal Pipe	5

If deflection readings in excess of the allowable deflection are obtained, remove the pipe with excessive deflection and replace with new pipe. Isolated areas may exceed allowable by 2.5% with concurrence of DEN PM. Repair or replace any pipe with cracks exhibiting displacement across the crack, bulges, creases, tears, spalls, or delaminations. The report for flexible pipe shall include as a minimum, the deflection results and final post installation inspection report. The inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design line and grade, and inspector's notes.

### **701-3.8 Quality Assurance/ Quality Control**

#### **a. Qualifications.**

1. Pipe Manufacturer: The Contractor shall submit verifiable information of satisfactory manufacturing experience for the past 5 years with design and fabrication of reinforced concrete pipe of similar size and design.
2. Installer: Contractor shall submit verifiable information of satisfactory experience in the installation of reinforced concrete storm sewer pipe of similar size and extent, with a minimum of 5 years experience.

#### **b. Testing.** All pipe shall be certified by the pipe manufacturer.

1. Yard testing of Pipe for Certification. Testing shall be performed in accordance with ASTM C 443 on a minimum of two (2) lengths of pipe and one (1) complete joint for every 500 linear feet of pipe, or less.
2. Testing of Installed Pipe. ASTM C 1103 shall be followed to field test pipe joints. The test procedure shall be used for joint acceptance of all installed concrete pipe. All field joints shall be tested and certified before backfilling operations are allowed to begin.

Acceptance testing may involve hazardous materials, operations and equipment. These specifications do not address the safety problems associated with the testing procedures. It is the responsibility of the Contractor to establish appropriate safety and health practices.

3. Repair of Joints that Test as Unacceptable. In the event of a reinforced concrete pipe joint failing the in-place pressure test, identified above, the Contractor shall repair the joint by injecting a chemical grout into the joint circumference.

The chemical grout shall be a non-flammable liquid which, when activated by water, forms a flexible closed-cell polyurethane foam. The chemical grout shall be resistant to petroleum products. The chemical grout shall be DE NEEF® Flex LV PRe or DE NEEF® Flex SLV PRe, as applicable, manufactured by GCP Applied Technologies Inc., Cambridge, MA 02140, or approved equal. Chemical grout shall be prepared, mixed, injected and cured in accordance with the manufacturer's recommendations.

The equipment used to inject the chemical grout shall be of construction similar to that of the pressure testing equipment. Chemical grout shall be injected into the joint at a in accordance with the manufacturer's recommendations to insure the grout penetrates through the leak to the outside of the joint.

After injecting the chemical grout, the injection valves shall be shut off to prevent backflow of the grout. The chemical grout shall have adequate time to cure prior to removal of the injection equipment. The joint shall be retested after repair in accordance with the pressure testing procedure described in these specifications.

4. Gasket Material Test. Gaskets may be exposed to petroleum products. Gasket material shall be certified to have complied with ASTM C 443 and petroleum resistant characteristics of ASTM C 361.

5. Backfill Tests. Refer to Section P-152 for test and test frequency.

**c. Submittals.** The Contractor shall make the following submittals to the Project Manager for review and approval, or testing, as the case may be:

1. Pipe Design and Detail Drawings. If the Contractor elects to use an alternate pipe, then the Contractor shall prepare or cause to be prepared, complete design calculations, plans, cross-sections, shop details for all pipe and accessories, and trench shoring/bracing system design for all trenches 20 feet in depth or greater. All final design calculations, plans, and shop drawings shall be sealed by a currently registered Professional DEN Project Manager in the State of Colorado whose disciplines is in the field of civil or structural engineering.

2. Qualifications. Refer to 701-3.6a.

3. Pipe Certification. The Contractor shall submit the results and certifications for tested pipe made in the pipe manufacturer's shop (refer to Part 701-3.6a.(1)). The Contractor shall further provide certification of each spool piece of pipe as it is delivered to the job site.

This certification shall accompany the pipe bill of lading.

**d. Pipe Field Joint Test Certification.** The Contractor shall maintain records of all pipe joint tests. A copy of these test records shall be turned over to the Project Manager with a letter certifying that all joints under construction have been tested in accordance with the specifications for joint seal and integrity.

**e. Pipe Manufacturer’s QA/QC Program.** The manufacturer of reinforced concrete pipe shall have in place at all times an active Quality Assurance and Quality Control Program. A written copy of this program shall be on file in the manufacturer’s shop at all times. The Contractor shall submit copies of the QA/QC Program to the Project Manager for review and approval prior to the start of manufacture of pipe.

**f. Mill Test Certificates.** The pipe manufacturer to retain on file a copy of mill certification reports for the reinforcing steel and cement used in the manufacture of the concrete pipe. An appropriate number of copies of said certifications shall be submitted to the Project Manager.

**g. Pipe Gasket Certification Test.** The Contractor shall selectively test the “O” ring synthetic rubber gasket material at an approved independent testing laboratory. Certified results shall be submitted to the Project Manager for review and approval.

**h. Inspection.** All pipe shall be inspected at the yard prior to shipment, at the point of receipt and when placed in the trench prior to backfilling. The Project Manager shall inspect all pipe to be used for damage prior to installation. Pipe shall be inspected for damage and compliance to the manufacturer’s specifications and Contract Drawings. Units that are damaged shall be evaluated for the extent of damage. If, in the opinion of the Project Manager, damage is extensive enough to reduce the strength, durability, integrity, or ability to properly function with other parts of an installation (i.e. joint damage), the unit shall be rejected and the Contractor shall immediately remove the unit from the Project site. The Contractor may repair minor damage, if so authorized by the Project Manager, but at no cost to the City.

#### METHOD OF MEASUREMENT

**701-4.1** The length of pipe shall be measured in linear feet (m) of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. Each class, type and size of pipe shall be measured separately. Pipe encasement and all fittings shall be included in the footage as typical pipe sections in the pipe being measured.

#### BASIS OF PAYMENT

**701-5.1** These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, bedding, backfill, encasement, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

**701-5.2** Payment will be made at the contract unit price per linear foot for the following pipe installed complete in place, and accepted by the DEN PM:

Item D-701-5.1	18-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.2	24-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.3	30-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.4	36-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.5	24-Inch PVC (Schedule 80)
Item D-701-5.6	42-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.7	48-Inch Reinforced Concrete Pipe (Class V)
Item D-701-5.8	54-Inch Reinforced Concrete Pipe (Class V)

Item D-701-5.9 60-Inch Reinforced Concrete Pipe (Class V)

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

#### ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar

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ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3282	Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

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ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
National Fire Protection Association (NFPA)	
NFPA 415	Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways

**END ITEM D-701**

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## Item D-702 Slotted Drains and Trench Drains

### DESCRIPTION

**702-1.1** This item shall consist of the construction of steel slotted drains, cast iron slotted vane drains or trench drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans. Typical details shall be shown on the plans.

### MATERIALS

**702-2.1 General.** All slotted drains shall meet the requirements shown on the plans and specified below. All slotted drains shall meet specified hydraulic design requirements and shall support the loadings specified.

**702-2.2 Trench Drain Channels.** Trench drain channels shall be pre-formed modular units with interlocking joints. Each channel segment shall be at least 6 ¼ inches wide for section in VSR areas and at least 12 inches wide inner diameter. Trench slope and depth is as specified on the drawings. Deviations from plan slope, width, and depth shall not be allowed as it directly impacts hydraulic capacity, storage capacity, and velocity. Channels shall have a radius or trapezoidal bottom as shown on plans and will allow for a monolithic concrete pour eliminating cold joints and water stop materials from being used in the trench invert. Forms and removal of forms shall not interfere or compromise the structural integrity of the load transfer assembly between the frame and encapsulation concrete. Forms, mounting brackets and liners shall be fully removed, without exception, to allow for 100% inspection of concrete consolidation. Inspection of consolidation below frames shall be 100%, partial inspection points will not be allowed. Formwork assembly must be prevented from floating during concrete placement without penetrating the sub grade. A means to assure constant frame spacing and grate seat dimension shall be provided.

Trench drain channels shall be supplied with epoxy lining. Epoxy lining type shall be submitted to the DEN Project Manager (DEN PM) for approval, prior to procuring trench drain systems for installation.

- a. **Steel slotted drain.** Not used.
- b. **Cast iron slotted vane drain.** Not used.

**702-2.3 Frames and Grates.** Frames for channel units shall be either cast-iron, ductile-iron, or galvanized steel and shall have anchors designed to provide positive anchorage into the surrounding concrete. Frames shall have a minimum of two anchors attached to each side for each channel unit. Frames shall be capable of being mechanically fastened to the channel unit.

Grates shall be either cast iron or ductile iron and shall be rated for an aircraft wheel load of 200,000 pounds with a maximum tire pressure of 250 psi.

Grates shall have a minimum of four locking devices to securely fasten the grate to the frame or to the channel unit to prevent the grate from becoming loose under traffic conditions. The locking devices shall be designed to allow easy installation and removal of the grates from the

completed trench drain, not obstruct flow in the channel, and not require any modifications to the channel units or frames to install the devices.

- a. **Steel Slotted Drain** Not used.
- b. **Cast iron slotted vane drain.** Not used.

**702-2.4 Concrete.** Concrete used shall conform to the requirements of Item P-610.

**702-2.5 Steel Reinforcement.** Reinforcing used in the concrete slab surrounding the modular trench drain system shall consist of deformed steel bars conforming to the requirements of ASTM A184. The steel shall be epoxy coated (green bar).

**702-2.6 Pre-Molded Joint Filler.** Pre-molded joint filler for expansion joints around the trench drain shall conform to the requirements of P-604A Preformed Expansion Joint Compression Seals. The filler for contract joints shall conform to the requirements of P-605 Joint Sealants for Pavements.

**702-2.7 Joint Sealer.** The joint sealer for the concrete joints shall meet the requirements of item P-605 joint sealing filler.

**702-2.8 Outlet Pipe.** Pipe for trench drain outlets shall be Schedule 80 galvanized steel and shall meet the requirements for ASTM A53.

**702-2.9 Cover Material for Curing.** Curing materials shall conform to the requirements of Item P-610.

**702-2.10 Submittals.** The Contractor shall submit shop drawings for the modular trench system in accordance with Section 013300 Submittal and Procedures and Section 013325 Shop and Working Drawings, Product Data and Samples. Shop drawings shall include the manufacturer's name, material specifications, hydraulic data, copies of test data determining wheel load capacity, installation procedures, and the proposed layout of the system with all appropriate dimensions.

**702-2.11 Acceptable Manufacturers.** The following manufacturers are known to have acceptable modular trench drain systems.

<u>Installation Location</u>	<u>Product Name</u>	<u>Manufacturer</u>
Aircraft Areas	Z874 Perma-Trench	Zurn
	Polydrain	ABT Inc.
GSE Areas	Polydrain	ABT, Inc.

Modular trench drain systems shall be one as listed above or approved equal. Request for approval of equal or equivalent trench system shall be submitted at least 10 days prior to ordering materials. In addition to technical data, a full-scale section shall be provided for examination.

**702-2.12 Warranty.** The Manufacturer shall provide a warrant on the materials furnished for 5 years from the date of Substantial Completion. The Contractor shall provide a warrant on the installation for 5 years from the date of Substantial Completion.

## CONSTRUCTION METHODS

**702-3.1 Excavation.**

The Contractor shall excavate existing base or subgrade materials as required to install the trench drain system to the lines, grades or elevations shown on the Contract Drawings. The Contractor shall accomplish the required excavation in such a manner so as not to damage drainage structures or adjacent concrete pavement. After the excavation is completed for each section of trench drain, the DEN PM shall approve the depth of the excavation and the condition of the trench bottom before the Contractor places any reinforcing steel, channel units or concrete.

Excavation shall not be measured for direct payment. The cost of this work shall be included in the contract unit price for trench drains.

**702-3.2 Installation.** Modular trench drain channel units shall be installed in accordance with the details on the Contract Drawings and with the manufacturer's recommendations. Channel units and outlet pipes shall be securely fastened in place so that they will not be displaced or moved during the placing of the concrete. The use of soil, sand, stone or wood to support the bottom or sides of the channel units or outlet pipes will not be allowed.

The Contractor shall set the trench drain channels in such a manner so as to maintain proper horizontal and vertical alignment. Channels shall be set with the top of the grate 1/2 inch below the elevation of the adjacent finished concrete. Channels shall be properly secured to hold the set horizontal and vertical alignment and to prevent floatation prior to placing the surrounding concrete. Frames shall be secured to the channels and grates wrapped with a protective material and locked in place before placing the concrete. Grates may be replaced with a temporary cover that can be securely fastened to the channel and is suitable to prevent concrete from entering the channels.

**702-3.3 Placing Reinforcement.** All reinforcement shall be accurately placed, as shown on the Contract Drawings, and shall be firmly held in position during concreting. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs.

**702-3.4 Placing Concrete Backfill.** After the installation of the trench drain channels and the reinforcing steel has been approved in accordance with Item P-610, the Contractor shall place concrete backfill around the trench drain. The concrete shall be placed with an approved discharge device that will not allow segregation of the materials and will not allow the concrete to chute directly against the channel sides. The concrete placement shall alternate from side to side to prevent disturbing the set channel alignment and shall be continuous between expansion joints. Concrete shall be thoroughly consolidated against and along the faces of the adjacent concrete pavement and along the full length and on both sides of the trench drain by means of vibrators inserted in the concrete. Vibrators shall not be allowed to come in contact with the trench drain channels or the grade and shall not be allowed to operate longer than 3 seconds in anyone location. Necessary hand spreading of concrete shall be done with shovels, and not with rakes or vibrators.

The forms holding the trench drain assembly shall be backfilled with concrete that will easily flow under and around the reinforcement and grating material. The top of grates and castings shall be covered to prevent unwanted material from entering the drain during the backfilling and subsequent surfacing operations.

**702-3.5 Joints.** Expansion joints shall be installed as indicated on the Contract Drawings. The pre-molded filler shall be securely fastened into position with a metal cap provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has

been placed and struck off, the cap shall be carefully withdrawn leaving the space over the pre-molded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic.

Contraction joints shall be formed in the plastic concrete using a preformed insert material as indicated on the Contract Drawings. The installation and edge finish shall be according to the manufacturer's instructions. Contractor shall create contraction joints, concurrent with trench drain installation, while the concrete is still plastic. Green sawing the joints after the trench is placed is not proper means-and-methods for achieving the desired results. Use of a rigid polystyrene extrusion that creates a straight-line controlled crack (contraction joint) in the concrete is permitted, to eliminate random cracking in all variations and thicknesses of slabs where a control joint is required.

The trench drain section contains a reinforcing steel cage, with surface clearance to the steel of 3-inches minimum. Extrusion material shall be installed to a depth (2-inch minimum) which provides for 1-inch clearance overtop the steel for corrosion protection.

**702-3.6 Surface Finish.** Final strike off and finishing of the concrete surface shall be accomplished in accordance with Item P-501.

**702-3.7 Sealing Joints.** The joints in the trench drain concrete slab shall be sealed in accordance with Item P-605.

**702-3.8 Cleaning and Restoration of Site.** Grates or temporary covers shall be removed if grates were wrapped with protective material, this material shall be removed to permit final cleaning and inspection. Clean any deposited concrete on other debris from the trench drain channel. Install grates in the trench drain frame and lock the grates down with the locking device provided by the manufacturer.

**702-3.9 Acceptance Sampling and Testing.** Sampling and testing of concrete backfill shall be in accordance with Item P-610.

## **METHOD OF MEASUREMENT**

**702-4.1** The accepted quantity of trench drain shall be measured in linear feet as a complete unit, irrespective of trench drain depth, for completed and approved trench drain. It shall be measured along the center of the trench drain slab from the outside face of the abutting inlet structure to the end of the trench drain slab or to the outside face of the abutting inlet structure, whichever is applicable. No separate measurement will be made for trench base preparation and backfill materials, concrete, steel reinforcing, or trench drain outlet pipes, as these items shall be considered incidental to the pay item installation.

## **BASIS OF PAYMENT**

**702-5.1** Payment shall be made at the contract unit price per linear foot for complete, in-place, and approved trench drain. This price shall be full compensation for all materials, including trench drain channels, grates and frames, outlet pipes, reinforcing steel, and concrete backfill and installation of these materials and all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D-702-5.1      Install Trench Drain – per linear foot

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

### ASTM International (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A184	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types)
ASTM D1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

### American Association of State Highway and Transportation Officials (AASHTO)

AASHTO-AGC-ARTBA Task Force 13 Report A Guide to Standardized Highway Drainage Products

**END OF ITEM D-702**

**TECHNICAL SPECIFICATIONS  
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ITEM D-702 SLOTTED DRAINS AND TRENCH DRAINS**

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## Item D-705 Pipe Underdrains for Airports

### DESCRIPTION

**705-1.1** This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

### MATERIALS

**705-2.1 General.** Materials shall meet the requirements shown on the plans and specified below.

**705-2.2 Pipe.** The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
ASTM F758	Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

**705-2.3 Joint mortar.** Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206.

**705-2.4 Elastomeric seals.** Elastomeric seals shall conform to the requirements of ASTM F477.

**705-2.5 Porous backfill.** Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

**Table 1. Gradation of Porous Backfill**

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. *
1-1/2 inch (37.5 mm)	100*
1 inch (25.0 mm)	90 - 100*
3/8 inch (9.5 mm)	25 - 60*
No. 4 (4.75 mm)	5 - 40*
No. 8 (2.36 mm)	0 - 20 *

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

**705-2.6 Granular material.** Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

**705-2.7 Filter fabric.** The filter fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent.

**Table 2. Fabric Properties**

Fabric Property	Test Method	Test Requirement
Grab Tensile Strength, lbs	ASTM D4632	125 min
Grab Tensile Elongation %	ASTM D4632	50 min
Burst Strength, psi	ASTM D3787	125 min
Trapezoid Tear Strength, lbs	ASTM D4533	55 min
Puncture Strength, lbs	ASTM D4833	40 min
Abrasion, lbs	ASTM D4886	15 max loss
Equivalent Opening Size	ASTM D4751	70-100
Permittivity sec <sup>-1</sup>	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

**705-2.8 Controlled low-strength material (CLSM).** Controlled low-strength material shall conform to the requirements of Item P-153. All joints shall have elastomeric seals.

**705-2.9 Concrete.** Concrete shall conform to the requirements of Item P-610.

**705-2.10 Castings.** Metal frames and covers for cleanouts shall be gray iron castings conforming to the requirements of ASTM A48, Class 20.

## CONSTRUCTION METHODS

**705-3.1 Equipment.** All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the DEN PM before construction is permitted to start.

**705-3.2 Excavation.** The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly

compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The DEN PM shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the DEN PM. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the DEN PM and compacted to the density of the surrounding material.

The pipe bedding shall be constructed uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 inch when the bedding thickness is less than 6 inches, and 1-1/2 inch when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed, uncompacted material under the middle third of the pipe prior to placement of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

### **705-3.3 Laying and installing pipe.**

**a. Concrete pipe.** The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and re-laid by the Contractor at no additional expense. Making adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it shall be prohibited. If the installed pipe section is not to grade, the pipe section shall be completely removed, the grade corrected, and the pipe rejoined.”

**b. Metal pipe.** The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands that is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

**c. PVC, fiberglass, or polyethylene pipe.** PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321. Perforations shall meet the requirements of

AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Fiberglass per ASTM D3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

**d. All types of pipe.** The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the DEN PM.

Unless otherwise shown on the plans, a 4-inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

**e. Filter fabric.** The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with the AASHTO M288 Appendix, unless otherwise shown on the plans.

**705-3.4 Mortar.** The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

**705-3.5 Joints in concrete pipe.** When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches (75 mm) nor more than 6 inches (150 mm), unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2 (Table 1), as shown on the plans or as directed by the DEN PM.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the DEN PM.

### **705-3.6 Embedment and Backfill**

**a. Earth.** All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The embedment material shall be select material from excavation or borrow and shall be approved by the DEN PM. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the DEN PM. The material shall be moistened or dried, as required to aid compaction. Placement of the embedment material shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The embedment material shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches (200 mm). Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the DEN PM, until the trench is completely filled and brought to the planned elevation. Embedment and backfilling shall be done to avoid damaging top or side of the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

**b. Granular backfill.** When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the DEN PM, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

**c. Controlled low-strength material (CLSM).** Controlled low-strength material shall conform to the requirements of Item P-153.

**705-3.7 Flexible Pipe Ring Deflection.** The flexible pipe shall be inspected by the Contractor during and after installation to ensure that the internal diameter of the pipe barrel has not been

reduced by more than 5 percent. For guidance on properly sizing mandrels, refer to ASTM D3034 and ASTM F679 appendices.

**705-3.8 Connections.** When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

**705-3.9 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the DEN PM. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

### METHOD OF MEASUREMENT

**705-4.1** The length of pipe shall be the number of linear feet of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

**705-4.2** The quantity of filter fabric shall not be measured or paid for separately but will be considered incidental to the project. The work under this item shall be considered subsidiary to the other items of work.

**705-4.3** The quantity of underdrain cleanouts and connection to existing underdrain cleanouts shall be the number of in place, completed, and approved structures. All trenching, excavation, removal of excavated material, backfill, compaction, concrete, and pipe fittings shall be included in the number of underdrain cleanouts being measured.

### BASIS OF PAYMENT

**705-5.1** Payment will be made at the contract unit price per linear foot (meter) for pipe underdrains of the type, class, and size designated.

**705-5.2 Filter fabric.** Filter fabric shall be considered incidental to the project. No payment shall be made for filter fabric.

**705-5.3 Pipe underdrains, Complete.** Pipe underdrains, complete (including porous backfill and filter fabric) shall be made at the contract unit price per linear foot complete (including porous backfill and filter fabric).

**705-5.4 Install Underdrain Cleanout.** The accepted quantity of underdrain cleanouts and connections to existing cleanouts will be paid for at the contract unit price per each in place when completed.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D-705-5.1	6-Inch Perforated Underdrain Pipe – per linear foot
Item D-705-5.2	6-Inch Non-Perforated Underdrain Pipe – per linear foot
Item D-705-5.3	Underdrain Cleanout – per each

Item D-705-5.4	Underdrain Connection to Inlet – per each
Item D-705-5.5	Connect to Existing Underdrain – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C206	Standard Specification for Finishing Hydrated Lime
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM D-705 PIPE FOR UNDERDRAINS FOR AIRPORTS**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

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American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M190	Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500- mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO	Standard Specifications for Highway Bridges

**END OF ITEM D-705**

## ITEM D-710 SOIL RIPRAP

### DESCRIPTION

**710-1.1** This item shall consist of furnishing and placing of soil riprap as shown on the plans and called for in these specifications. Where buried soil riprap is called out on the plans, six (6) inches of topsoil will be placed on top of the soil riprap. Placing of riprap will include all mixing and soil placement, bedding (if applicable), fabric (if applicable), and stones as indicated on the plans or as directed by the DEN Project Manager.

### MATERIALS

**710-2.1** **STONE.** All stone for rock riprap shall be sound, durable, and free from seams, cracks, and other defects and shall be as nearly rectangular as practicable. Rounded riprap (river rock) is not acceptable. The stone shall have a specific gravity of at least 2.5.

- a. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.
- b. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
- c. The bulk density for the riprap shall be 1.3 ton/cy or greater.
- d. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
- e. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
- f. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
- g. Rock shall be free of calcite intrusions.
- h. Gradation:
  1. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.

2. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.
3. Gradation of Type M Riprap shall be as shown in Table 1 below.

**Table 1.**

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension Inches	d <sub>50</sub> * inches
Type L	70-100	15	9
	50-70	12	
	35-50	9	
	2-10	3	
Type M	70-100	21	12
	50-70	18	
	35-50	12	
	2-10	4	
Type H	70-100	30	18
	50-70	24	
	35-50	18	
	2-10	6	

\*d<sub>50</sub> = Mean particle size

**710-2.2 SUBMITTALS.** Contractor shall submit certification that the product delivered to the project site will have values equal to or greater than those specified above.

Stone – Certification of Compliance detailing gradation and specific gravity.

### CONSTRUCTION METHODS

**710-3.1 EXCAVATION.** The slopes shall be finished to a reasonably smooth and compact surface within 2 inches (5 cm) of the lines, surfaces, and elevations shown on the plans.

### 710-3.2 SOIL RIPRAP.

- a. Adjacent stockpiles of riprap and soil shall be created, and mixing done at the stockpile location, not at the location where soil riprap is to be placed.

- b.** Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.
- c.** Place a first layer of smaller soil riprap of approximate d50 thickness. Then place the top layer with surface rocks that are largely d50 or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane with projections above or depressions under the finished design grade no more than ten percent (10%) of the rock layer thickness.
- d.** The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.
- e.** The soil shall be further wetted to encourage void filling with soil.
- f.** Excessively thick zones of soil prone to washing away shall not be created; no thickness greater than 6 inches.
- g.** For buried soil riprap, the top surface shall be covered with six (6) inches of topsoil such that no rock points are protruding.
- h.** The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

#### **METHOD OF MEASUREMENT**

**710-4.1** Soil Riprap shall be measured by the cubic yard, to the dimensions of the riprap as shown on the plans or as directed by the DEN Project Manager. Excavation and mixing are included in the contract unit price for Soil Riprap and no separate measurement of payment will be made for them.

#### **BASIS OF PAYMENT**

**710-5.1** The accepted quantity of Riprap will be paid for at the contract unit price per cubic yard. The price shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

- Item D-710-5.1      Type “L” Soil Riprap – Per Cubic Yard
- Item D-710-5.2      Type “H” Soil Riprap – Per Cubic Yard

#### **END OF ITEM D-710**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM D-710 SOIL RIPRAP**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

### DESCRIPTION

**751-1.1** This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the DEN PM.

### MATERIALS

**751-2.1 Brick.** Not used.

**751-2.2 Mortar.** Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**751-2.3 Concrete.** Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

**751-2.4 Precast concrete pipe manhole rings.** Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

**751-2.5 Corrugated metal.** Not used.

**751-2.6 Frames, covers, and grates.** The castings shall conform to one of the following requirements:

- a. ASTM A48, Class 35B: Gray iron castings
- b. ASTM A47: Malleable iron castings
- c. ASTM A27: Steel castings
- d. ASTM A283, Grade D: Structural steel for grates and frames
- e. ASTM A536, Grade 65-45-12: Ductile iron castings
- f. ASTM A897: Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Castings shall be coated per DEN Division 09 requirements.

**751-2.7 Steps.** Steps or ladders shall not be installed in any structure, including: vaults, manholes, handholes, storm structures, sanitary structures, jet-fuel structures, EFSO structures electrical structures, etc., unless directed otherwise by the DEN PM.

**751-2.8 Precast inlet structures.** Manufactured in accordance with and conforming to ASTM C913.

**751-2.9 Reinforcing Steel.** All reinforcing steel be manufactured in accordance with and conforming to ASTM A615, Grade 60.

**751-2.10 Epoxy Lining System.** 100 percent solids, plural component epoxy, capable of spray or trowel application. System capable of application to damp concrete in high relative humidity environment. Resistant to attack from hydrogen sulfide and sulfuric acids generated from microbiological sources. System shall meet requirements of ASTM C722 and ASTM D1763, and be 100 percent solids epoxy resin. A minimum finish thickness of 125 mils is required. Properties: Minimum requirements are as follows. If a specific manufacturer product is identified in the following sections, the minimum requirements are per the individual product.

- a. Bond Strength, ASTM C478: Concrete failure.
- b. Tensile Strength, ASTM C307: 2,500 psi, minimum.
- c. Flexural Strength, ASTM C580: 4,800 psi.
- d. Moisture Absorption, ASTM C413: 0.1 percent.
- e. Shrinkage, ASTM C631: 0.11 percent, maximum.

Manufacturers and Products:

Manufacturers	Products
1. Environmental Coatings, Inc.	Sewer-Shield 100 (Trowel) Sewer-Shield 101S (Spray) Sewer-Shield 101A Sewer-Shield 150
2. Sauereisen, Inc.	SewerGard 210X Epoxy
3. Warren Environmental, Inc.	S-301 Epoxy

## CONSTRUCTION METHODS

### 751-3.1 Unclassified excavation.

**a.** The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as staked by the DEN PM. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the DEN PM may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

**b.** Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut

to a firm surface either level, stepped, or serrated, as directed by the DEN PM. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After excavation is completed for each structure, the Contractor shall notify the DEN PM. No concrete or reinforcing steel shall be placed until the DEN PM has approved the depth of the excavation and the character of the foundation material.

#### **751-3.2 Brick structures. Not used.**

**751-3.3 Concrete structures.** Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. When claystone (undisturbed natural or fill) is encountered in the base of the excavation within paved areas as determined by the DEN Project Manager, the material shall be over-excavated to a depth of 3 feet below and 3 feet beyond the sides of the base of the structure. The over-excavation shall be replaced with Select Embankment material meeting the requirements for Item P-152. The Select Embankment material shall be placed in 8 inch thick loose lifts, moisture conditioned and compacted to the requirements of Item P-152.

The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the DEN PM before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

**751-3.4 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another DEN PM approved third party certification program.

When required by the DEN Project Manager, the precast manufacturer shall provide detailed structural analysis of the structure being provided that considers the live and dead loads exposed to the structure. The analysis shall be signed and sealed by an engineer registered in the state of installation normally performing structural engineering.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required.

Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

**751-3.5 Corrugated metal structures.** Not used.

**751-3.6 Inlet and outlet pipes.** Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

**751-3.7 Placement and treatment of castings, frames, and fittings.** All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the DEN PM, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the DEN PM. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

**751-3.8 Installation of steps.** Steps or ladders shall not be installed in any structure, including: vaults, manholes, handholes, storm structures, sanitary structures, jet-fuel structures, EFSO structures, electrical structures, etc., unless directed otherwise by the DEN PM.

**751-3.9 Epoxy Lining.**

**a. Coverage:** System shall be applied/cover all walls, underside of top slab, chimney, corbel, bench, and invert of the manhole. System shall be applied after manhole is completely constructed in its permanent location to prevent seams or gaps in the lining.

**b. Surface Preparation:** Perform surface preparation in presence of DEN Project Manager or designated representative, unless DEN Project Manager agrees Work may be performed in DEN Project Manager's or designated representative's absence. Clean and prepare surface of new concrete in accordance with recommendations of manufacturer.

**c. Inflow and Infiltration:** Do not apply coating if inflow or infiltration are present. New manholes should be constructed to prevent inflow and infiltration. If inflow or infiltration are present notify DEN Project Manager or designated representative.

**d. Installation:** DEN Project Manager or designated representative will inspect all cleaned and repaired manholes before application of lining system; provide 24 hour notification. Apply or install system in accordance with the manufacturer's recommendations. Upon completion of work, DEN Project Manager or designated representative will inspect all rehabilitated manholes and be present for testing. Manufacturer/manufacturer's representative shall inspect all rehabilitated manholes.

**751-3.10 Backfilling.**

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the DEN PM.

b. Backfill shall not be placed against any structure until approved by the DEN PM. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

**751-3.11 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the DEN PM. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

**751-3.12 Quality Assurance/ Quality Control.**

a. Qualifications. The Contractor shall meet the same qualifications for precast pipe structures as are identified in Item D-701 and shall impose all qualifications on its pipe manufacturer. Should the Contractor elect to cast-in-place junction structures, the Contractor shall be able to demonstrate experience with similar structures.

b. Tests. Tests for precast concrete pipe structures (including pipe joints) shall have imposed the same tests as for precast pipe in Item D-701. Refer to Item P-610 for cast-in-place concrete test requirements. All backfill material shall be tested for compaction in accordance with Items D-701 and P-152.

(1) Epoxy lining: Measure and record twice daily air, concrete substrate, and lining surface temperatures within structure during mixing, application, and curing of materials; verify compliance with manufacturer's temperature ranges. Measure and record twice daily relative humidity within structure during mixing, application, and curing of materials; verify compliance with manufacturer's requirements. Wet Film Thickness Gauge: During application, use wet film thickness gauge; meet ASTM D4414 to ensure monolithic coating and uniform thickness. Holiday Detection: In accordance with NACE SPO 188. After 24 hours minimum, spark test lining system to ensure pinhole-free lining. Mark defects and repaired per manufacturer's instructions. Voltage to be set at 100 volts per mil of epoxy thickness. After identification of pinholes, thin areas, and other imperfections, re-apply epoxy material and retest. Adhesion Test: Test 10 percent minimum of manholes for adhesion/bond of coating to substrate. DEN Project Manager or designated representative will select manholes to be tested. Conduct in accordance with ASTM D7234 as modified herein. Prepare coating and dollies to receive adhesive. Attach three 20 millimeter dollies minimum. Adhesive used to attach dollies to coating shall be rapid setting with tensile strength in excess of coating product and permitted to cure in accordance with manufacturer's recommendations. Deemed failure of if pull value is lower than required minimum shall be deemed a non-test and require retesting. Prior to performing pull test, score through applied coating into substrate by 30 mils by mechanical means without disturbing dolly or bond within test area. Two (2) of the three (3) adhesion pulls shall exceed

200 psi or concrete failure with more than 80 percent of subsurface adhered to coating. Should a structure fail to achieve two successful pulls as described above, perform additional testing at discretion of DEN Project Manager. Areas detected to have inadequate bond strength shall be evaluated by DEN Project Manager or designated representative. Further bond tests may be performed in area to determine extent of potentially deficient bonded area. Repair deficient areas.

c. Inspections. Inspection for precast concrete pipe structures shall follow inspection procedures identified in Item D-701 for precast pipe and those of Item P-152 for excavation. Inspection for cast-in-place concrete structures shall follow Item P-610.

d. Submittals.

1. Materials. Materials shall be submitted in accordance with Items P-610 and D-701.
2. Designs and Drawings. If the Contractor elects to use an alternative pipe, then the Contractor shall design or cause the pipe manufacturer to design all precast pipe structures to the specified criteria. The Contractor shall submit support calculations, installation drawings, and detail drawings for review and approval by the Project Manager prior to proceeding with fabrication of structures. Calculations, drawings, and details shall be sealed and signed by a Professional Engineer currently registered in the State of Colorado.

Should the Contractor elect to substitute and construct precast and/or cast-in-place concrete structures, the Contractor shall submit full designs and details, as above, sealed and signed by a Professional Engineer currently registered in the State of Colorado.

### **METHOD OF MEASUREMENT**

**751-4.1** Manholes, inlets, diversion structures, inspection holes, connections to and adjustment of structures shall be measured by the unit complete in place and accepted by the DEN PM.

### **BASIS OF PAYMENT**

**751-5.1** The accepted quantities of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item D-751-5.1	Type E Manhole (10' - 20' Depth) - per each
Item D-751-5.2	Type E Manhole (20' - 30' Depth) - per each
Item D-751-5.3	Type E Manhole (30' - 40' Depth) - per each
Item D-751-5.4	Type E Manhole (DIW Force Main) - per each
Item D-751-5.5	Type F Manhole (10' – 20' Depth) - per each
Item D-751-5.6	Type F Manhole (20' – 30' Depth) - per each

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Item D-751-5.7	Type F Manhole (30' – 40' Depth) - per each
Item D-751-5.8	Type G Manhole - per each
Item D-751-5.9	Type H Manhole (10' – 20' Depth) - per each
Item D-751-5.10	Type H Manhole (30' – 40' Depth) - per each
Item D-751-5.11	Type 1 Quad Inlet - per each
Item D-751-5.12	Type 2 Double Inlet - per each
Item D-751-5.13	Type 2 Triple Inlet - per each
Item D-751-5.14	Type 2 Quad Inlet - per each
Item D-751-5.15	Type I Diversion Structure, 2 Gates - per each
Item D-751-5.16	Type I Diversion Structure, 2 Gates, with Weir - per each
Item D-751-5.17	Type I Diversion Structure, with Weir - per each
Item D-751-5.18	Trench Drain Inlet (58" x 90")
Item D-751-5.19	Trench Drain Inlet (92" x 90")
Item D-751-5.20	Adjust Existing DIW Manhole - per each
Item D-751-5.21	Adjust Electrical Manhole - per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

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ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures.
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

END OF ITEM D-751

## **Item D-752 Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures**

### **DESCRIPTION**

**752-1.1** This item shall consist of plain and reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the DEN PM.

### **MATERIALS**

**752-2.1 Concrete.** Plain and reinforced concrete shall meet the requirements of Item P-610.

**752-2.2 Structural steel.** Structural steel for shall meet the requirements of ASTM A36 (Grade 60).

### **CONSTRUCTION METHODS**

#### **752-3.1 Unclassified excavation.**

**a.** Trenches and foundation pits for structures or structure footings shall be excavated to the lines and grades and elevations shown on the plans. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only; and the DEN PM may approve, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

**b.** Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the DEN PM. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing steel is placed.

**c.** The Contractor shall do all bracing, sheathing, or shoring necessary to perform and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for excavation.

**d.** All bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage the finished concrete. The cost of removal shall be included in the unit price bid for excavation.

**e.** After each excavation is completed, the Contractor shall notify the DEN PM. No concrete or reinforcing steel shall be placed until the DEN PM has approved the depth of the excavation and the character of the foundation material.

**752-3.2 Backfilling.**

a. After a structure has been completed, backfilling with approved material shall be accomplished by applying the fill in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required under item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the DEN PM.

b. No backfilling shall be placed against any structure until approved by the DEN PM. For concrete, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained 75% of its design strength to withstand any pressure created by the backfill or the placement methods.

c. Fill placed around concrete culverts shall be deposited on each side at the same time and to approximately the same elevation. All slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent wedge action against the structure.

d. Backfill will not be measured for direct payment. Performance of this work shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for the structures involved.

**752-3.3 Weep holes.** Weep holes shall be constructed as shown on the plans.

**752-3.4 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankment, shoulders, or as approved by the DEN PM. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

**752-3.5 Quality Assurance/ Quality Control.**

a. Inspection. Mandatory hold points are established for inspection by the Project Manager for all reinforcing steel, embedded items, and concrete placement for structures by Item P-610. Excavation shall be inspected when completed and after forms and reinforcing is installed in accordance with Item P-610. Final grading shall be inspected to assure smooth transition at and around drainage courses.

b. Testing. Refer to Item P-610 for concrete testing requirements and to Item P-152 for soils testing requirements.

c. Submittals.

(1) Reinforcing Steel Detail Drawings. All structure reinforcing steel shall be detailed and shop drawings provided in accordance with the requirements of Item P-610, including utility blockouts, expansion joints and construction joints.

(2) Waterstop product data in conformance with plans.

(3) Excavation and shoring drawings, if required..

**METHOD OF MEASUREMENT**

**752-4.1** Concrete headwalls (including wingwalls) and other miscellaneous drainage structures shall be measured by the unit.

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**752-4.1** Unclassified excavation, concrete and reinforcing steel required for the installation for each structure will not be measured but shall be considered incidental to each structure bid item.

### **BASIS OF PAYMENT**

**752-5.1** The accepted quantities of concrete headwalls (including wingwalls) and other miscellaneous drainage structures will be paid for at the contract unit price per each in place when completed and accepted by the DEN PM.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and placing the materials, and for all labor, equipment, tools, and incidentals necessary to complete the structure.

Payment will be made under:

Item D-752-5.1	60-Inch SDG Headwall - per each
Item D-752-5.2	24-Inch RCP Flared End Section - per each
Item D-752-5.3	30-Inch RCP Flared End Section - per each

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

**END OF ITEM D-752**

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## Item T-901 Seeding

### DESCRIPTION

**901-1.1** This item shall consist of soil preparation, seeding and fertilizing the areas shown on the plans or as directed by the DEN PM in accordance with these specifications.

### MATERIALS

**901-2.1 Seed.** The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the DEN PM duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be applied as follows:

#### Non-Saline Upland Seed Mix For Shoulder

Scientific Name	Common Name	Variety	lbs PLS/acre*	%of mix**
<i>Bouteloua curtipendula</i>	Sideoats Grama	Vaughn	0.8	10
<i>Bouteloua gracilis</i>	Blue Grama	Bad River	0.05	2.5
<i>Bouteloua gracilis</i>	Blue Grama	Hachita	0.05	2.5
<i>Buchloe dactyloides</i>	Buffalograss	Cody	0.7	2.5
<i>Buchloe dactyloides</i>	Buffalograss	Native – VNS <sup>†</sup>	0.7	2.5
<i>Distichlis spicata</i> v. <i>stricta</i>	Inland Saltgrass	Native – VNS <sup>†</sup>	0.3	5
<i>Elymus lanceolatus</i> v. <i>lanceolatus</i>	Thickspike Wheatgrass	Critana	1.1	11
<i>Elymus lanceolatus</i> v. <i>psammophilus</i>	Streambank Wheatgrass	Sodar	1.0	10
<i>Elymus trachycaulus</i>	Slender Wheatgrass	Primar	0.5	5

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Nasella viridula	Green Needlegrass	LoDorm	0.8	5
Poa secunda	Sandberg Bluegrass	Native – VNS <sup>†</sup>	0.5	5
Sporobolus cryptandrus	Sand Dropseed	Native – VNS <sup>†</sup>	0.01	4
Stipa comata	Needleandthread Grass	Native – VNS <sup>†</sup>	0.7	5
Grass species subtotal			10.81	100
	<b>TOTAL PLS RATE</b>		<b>10.81</b>	<b>100</b>

\* PLS means Pure Live Seed; rates shown are for drill seeding, if broadcast, rates should be doubled.

\*\* Percent by seed number

\*\*\* Wetland mixes to be used only where wetland hydrology exists. Check with DIA Environmental Services.

† VNS = Variety Not Stated

Seeding shall be performed during the period between spring thaw and July 1 or between October 15 and the freezing of the ground unless otherwise approved by the DEN PM.

**901-2.2 Lime.** Not required.

**901-2.3 Fertilizer.** Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be a commercial fertilizer and shall be spread at the rate of which is determined by the seeding contractor and/or supplier to allow for proper vegetative growth.

**901-2.4 Soil for repairs.** The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the DEN PM before being placed.

## **CONSTRUCTION METHODS**

**901-3.1 Advance preparation and cleanup.** After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

**901-3.2 Dry application method.** Not required.

**c. Seeding.** Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked in, or drill seeded, within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

(1) If drill seeding is used, the seed drill will be equipped with three seed boxes including one for large smooth seed, one for fluffy seed (with picker wheels to prevent bridging), and one for small smooth seed. Furrow spacing may vary between 7 and 9 inches. Drill will have double disc furrow openers and functioning depth bands set to plant at ½ inch depth. Drill will have either packer wheels or drag chains. Grain drills are NOT acceptable. Seeder-cultipackers are also not acceptable.

(2) If broadcast seeding is used, soil surface will be roughened IMMEDIATELY prior to seeding using a toothed-type harrow. Seed will be spread by hand or by cyclonic spreader at a rate TWICE that specified for drill seeding in Tables 901-1 and 901-2. Immediately following seeding, the treated area will be harrowed with a tooth-type harrow to cover the seed. Sufficient passes will be made to assure that seed is covered to a depth of at least ¼ inch. Brush or chain-link drags are not acceptable for this purpose.

**d. Rolling.** After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

**901-3.3 Wet application method.** Not used.

**901-3.4 Maintenance of seeded areas.** The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the DEN PM. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the DEN PM. A grass stand shall be considered adequate when bare spots are one square foot or less, randomly dispersed, and do not exceed 3% of the area seeded.

### METHOD OF MEASUREMENT

**901-4.1** The quantity of seeding to be paid for shall be the number of units acre measured on the ground surface, completed and accepted.

### BASIS OF PAYMENT

**901-5.1** Payment shall be made at the contract unit price per acre or fraction thereof, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

Item T-901-5.1          Seeding - per acre

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602                  Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC                  JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33          Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-901**

## Item T-905 Topsoil

### DESCRIPTION

**905-1.1** This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the RPR.

### MATERIALS

**905-2.1 Topsoil.** Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 µm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

**905-2.2 Inspection and tests.** Within 10 days following acceptance of the bid, the RPR shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

### CONSTRUCTION METHODS

**905-3.1 General.** Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the RPR before the various operations are started.

**905-3.2 Preparing the ground surface.** Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other

means approved by the RPR, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

**905-3.3 Obtaining topsoil.** Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the RPR. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the RPR. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the RPR. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoil purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the RPR. The Contractor shall notify the RPR sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

**905-3.4 Placing topsoil.** The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turving operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the RPR. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

## METHOD OF MEASUREMENT

**905-4.1** Topsoil obtained on the site shall be measured by the number of cubic yards of topsoil measured in its original position and stripped or excavated. Topsoil stockpiled by others and

removed for topsoil by the Contractor shall be measured by the number of cubic yards of topsoil measured in the stockpile. Topsoil shall be measured by volume in cubic yards computed by the method of end areas. Any excess topsoil not used, shall be considered Unclassified Excavation.

### **BASIS OF PAYMENT**

**905-5.1** Payment will be made at the contract unit price per cubic yard for topsoil (obtained on the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item T-905-5.1          Topsoil (Obtained On-Site) - per cubic yard

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C117                  Materials Finer than 75  $\mu\text{m}$  (No. 200) Sieve in Mineral Aggregates  
by Washing

Advisory Circulars (AC)

AC 150/5200-33          Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-905**

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DIVISION 2 – AIRFIELD STANDARDS  
ITEM T-905 TOPSOIL**

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## Item T-908 Mulching

### DESCRIPTION

**908-1.1** This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the DEN PM.

### MATERIALS

**908-2.1 Mulch material.** Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

- a. **Wood-fiber Mulch.** Wood fiber mulch must be virgin long-fiber material. Wood fiber shall be absent of materials toxic to plant growth. Wood chips are not acceptable.
- b. **Matting.**
  - (1) **Covering.** Covering shall consist of blankets with close weave mesh and nettings with open weave mesh made of various materials as specified herein.
  - (2) Blankets and nettings shall be biodegradable, non-toxic to vegetation or germination of seed, and shall not be toxic or injurious to humans.
    - (a) **Excelsior.**

The blanket shall consist of a machine produced mat of curled wood excelsior of 80 percent, 6 inch or longer fiber length with a consistent thickness of fibers evenly distributed over the entire area of the blanket. The top side of the blanket shall be covered with a biodegradable netting, manufactured from a jute or other biodegradable material and stitched on 2-inch centers the entire width of the blanket.

Dimensions:                    48" by 180' or 96" by 90'

Roll Weight:                    0.9 to 1.1 pounds per sq. yd.
    - (b) **Soil Retention Blanket (coconut).** Soil Retention Blanket (Coconut) shall be a machine produced mat consisting of 100 percent coconut fiber. The blanket shall be of consistent thickness with the coconut fiber evenly distributed over the entire area of the mat. The blanket shall be sewn together with biodegradable thread.

Material Requirements:

Coconut Fiber Content:            100%, 0.50 to 0.60 lb. per sq. yd

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Netting:	Both sides, biodegradable 9.3 lbs. per 1000 sq. ft.
Thread:	Biodegradable
Roll Width:	6.5 to 7.5 feet
Roll Length:	83.5 to 110 feet
<b>Area Covered by One Roll: 60 to 80 sq. yd</b>	

- (c) **Soil Retention Blanket (Straw).** Soil Retention Blanket (Straw) shall be a machine produced mat consisting of 100 percent agricultural straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with biodegradable netting having an approximate 5/8 inch x 5/8 inch to 1/2 inch x 1/2 inch mesh and on the bottom with biodegradable netting with an approximate 1/4 inch x 1/4 inch to 1/2 inch x 1/2 inch mesh. The blanket shall be sewn together with biodegradable thread.

Material requirements:

Straw Content:	100%, 0.50 lb. per sq. yd.
Netting:	Bottom side biodegradable, 9. lbs. per 1000 sq. ft.;
Netting:	Top side biodegradable, 9.3 lbs. per 1000 sq. ft.
Thread:	Biodegradable
Roll Width:	6.5 to 7.5 feet
Roll Length:	83.5 to 110 feet
Area Covered by One Roll:	60 to 80 sq. yds

A sample of the soil retention blanket (straw) shall be submitted at least 2 weeks in advance of its use on the project for approval by the Project Manager..

- (d) **Pins and Staples.** Pins and staples shall be made of wire 0.162 inch or larger in diameter. "U" shaped staples shall have legs 8 inches long and a 1 inch crown. "T" shaped pins shall not be used

c. Tackifier. Material for mulch tackifier shall consist of a free-flowing, organic, 100% all natural starch polymer, applied in a slurry with water and wood fiber

d. Stubble Mulch. Stubble mulch is the holdover debris of stems and leaves left from a small grain crop; these can function as mulch for a permanent seeding. One of the crop species below is used to establish a cover and mulch that functions as a standing mulch for subsequent seeding. NOTE: when using these species, the crop must be mowed to product stubble prior to producing seed.

**908-2.2 Inspection.** The DEN PM shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the

approval of the DEN PM and any materials brought on the site that do not meet these standards shall be rejected.

**908-2.3 Storage.** The Contractor shall store mulch with protection from weather or other conditions that would damage or impact the effectiveness of the product.

### **CONSTRUCTION METHODS**

**908-3.1 Mulching.** Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the DEN PM. Straw or hay shall be spread over the surface to a uniform thickness at the rate of 2 to 3 tons per acre (1800 - 2700 kg per acre) to provide a loose depth of not less than 1-1/2 inches (38 cm) nor more than 3 inches (75 mm). Other organic material shall be spread at the rate directed by the DEN PM. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches (150 mm) or more in length. When mulches applied by the blowing method are cut, the loose depth in place shall be not less than one inch (25 mm) nor more than 2 inches (50 mm).

**908-3.2 Securing mulch.** The mulch shall be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, matting, asphalt binder, or other adhesive material approved by the DEN PM. Where mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and will be held responsible for any such damage resulting from the operation.

If the “peg and string” method is used, the mulch shall be secured by the use of stakes or wire pins driven into the ground on 5-foot (1.5-m) centers or less. Binder twine shall be strung between adjacent stakes in straight lines and crisscrossed diagonally over the mulch, after which the stakes shall be firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

#### **908-3.3 Care and repair.**

**a.** The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the DEN PM, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

**b.** The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the DEN PM, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

**c.** If the “asphalt spray” method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100

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sq m), or as directed by the DEN PM, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it. Asphalt binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the asphalt material shall be required. A pump or an air compressor of adequate capacity shall be used to ensure uniform distribution of the asphalt material.

**d.** If the “asphalt mix” method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m) or as directed by the DEN PM, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it.

### **METHOD OF MEASUREMENT**

**908-4.1** Mulching shall be measured in square yards on the basis of the actual surface area acceptably mulched.

**908-4.2** Erosion Control Blankets shall be measured in square yards on the basis of the actual area of acceptably installed blankets.

### **BASIS OF PAYMENT**

**908-5.1** Payment will be made at the contract unit price per square yard (square meter) for mulching. The price shall be full compensation for furnishing all materials and for placing and anchoring the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item T-908-5.1	Mulching - per square yard
Item T-908-5.2	Erosion Control Blankets - per square yard

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D977	Standard Specification for Emulsified Asphalt
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Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports
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ITEM T-908 MULCHING**

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FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-908**

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**SECTION 221323 - SANITARY WASTE INTERCEPTORS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

Retain or delete this article in all Sections of Project Manual.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Oil interceptors.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of metal interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
  - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

**1.4 INFORMATIONAL SUBMITTALS**

Retain "Coordination Drawings" Paragraph below to require coordination of other trades involved in the installation of products listed below.

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Piping connections. Include size, location, and elevation of each.
  - 2. Interface with underground structures and utility services.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

## 1.6 FIELD CONDITIONS

Retain this article if interruption of existing sanitary or storm sewer service is required.

- A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of service.
  2. Do not proceed with interruption of sewer services without DEN PM's written permission.

## PART 2 - PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

### 2.1 OIL INTERCEPTORS

Indicate on Drawings the number, size, and arrangement of compartments and baffles in oil interceptors in. In "Precast-Concrete Oil Interceptors" Paragraph below, delete option and insert name(s) of authorities having jurisdiction for interceptors complying with requirements of authorities having jurisdiction.

- A. Steel Oil Interceptors: Factory fabricated and prepackaged; Underground Double-wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator(s). Separator shall be furnished with oil level alarm and leak detection
1. Inlet, Outlet, Vent, and Waste-Oil-Outlet Piping Connections: Hub, hubless, flanged or threaded unless otherwise indicated to connect into RCP pipes.
  2. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns
  3. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel (to the greatest extent possible with consideration to shipping requirements) ready for installation. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58. Tank design to comply with UL 2215 with coating systems both interior and exterior, electronic

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- monitoring system, coalescers size etc, effluent testing and verification the performance of the tank should be by the third party.
4. Separator shall consist of inlet and outlet connections, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, pre-settling area for solids, sludge baffle, oil coalescing chamber with removable parallel corrugated plates and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access manways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs. Dimensions of overall tank and each component refer to drawing.
  5. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi-hi oil level (audible and visual) of oil storage in the oil/water separator will be provided. An audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) to be intrinsically safe. Level sensor floats to be made of stainless steel. The control panel shall contain both level sensor and leak detection control. The control panel shall be NEMA 4. Power to the control panel is to be 120 volts/1 phase.
  6. Separator should be supplied with anchoring system that includes polyester or steel hold down straps and concrete Deadman anchors.
  7. External tank surfaces blasted and coated with 75 mils self-reinforcing polyurethane. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, Double-wall construction with 360-degree Steel Secondary Containment. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank must have a double steel shell without a defined space between the layers (UL Type I Double-wall). The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from the bottom of the shell.

"Extension" Subparagraph below is an optional feature. Retain only if required. Verify availability.

8. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
9. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C890, load.
10. Factory 10-year warranty for external corrosion and structure defects.
11. Level and leak sensors.
12. Two (2) 24-inch diameter manholes, UL approved, extensions to be completed based on the length based on burial depth, covers, gaskets, and bolts. One manway shall be placed between the inlet and the parallel-flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.

If more than one oil interceptor is required, delete "Capacities and Characteristics" Subparagraph below and schedule oil interceptors on Drawings.

13. Capacities and Characteristics:
- a. Capacity: 5,000 gallon and 6,000 gallon
  - b. Overall Dimensions: See Plan
  - c. Flow Rate: 450 gpm and 550 gpm
  - d. Inlet and Outlet Pipe Size: See Plan
  
  - e. End Connections: Flanged.
  - f. Waste-Oil-Outlet Pipe Size: 8" & 10".
  
  - g. Trapped Outlet Required: Integral.
  - h. Cleanout: Integral.
  - i. Mounting: On Concert Pad.
  - j. Flow-Control Fitting: Required.

### **PART 3 - EXECUTION**

#### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section

#### 3.2 INSTALLATION

- A. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

- 1. Install and oil interceptors on cast-in-place concrete equipment base(s).
  
- B. Set interceptors level and plumb.
  
- C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
  
- D. Set tops of manhole frames and covers flush with finished surface in pavements.
  - 1. Set tops 3 inches (75 mm) above finish surface elsewhere unless otherwise indicated.
  
- E. Set tops of grating frames and grates flush with finished surface.
  
- F. Set metal interceptors level and plumb.
  
- G. Set tops of metal interceptor covers flush with finished surface in pavements.
  - 1. Set tops 3 inches (75 mm) above finish surface elsewhere unless otherwise indicated.

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- H. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
- I. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.
  - 1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

### 3.3 IDENTIFICATION

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Oil interceptors.

### 3.4 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

## **PART 4 - METHOD OF MEASUREMENT**

- 4.1 Oil interceptor (oil/water separator), shall be measured by the unit complete in place and accepted by the DEN PM.

## **PART 5 - BASIS OF PAYMENT**

- 5.1 The accepted quantities oil/water separators will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item 221323-5.1      5000 Gal Oil/Water Separator - per each

Item 221323-5.2      6000 Gal Oil/Water Separator - per each

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**END OF SECTION 221323**

**SECTION 333123 - SANITARY SEWORAGE FORCE MAIN PIPING****PART 1 - GENERAL**

## 1.1 SUMMARY

## A. Section Includes:

1. Force mains.
2. PVC pipe.

## B. Related Requirements:

1. Section P-152 "Soils for Earthwork" for soil backfill from above pipe to finish grade.
2. Section P-152 "Aggregates for Earthwork" for aggregate for pipe bedding and cover.
3. Section P-152 "Trenching" for excavation, backfilling, compacting, and fill over underground pipe markers.
4. Section P-152 "Fill" for requirements for fill over underground pipe markers.

## 1.2 UNIT PRICES

## A. Pipe and Fittings:

1. Basis of Measurement: By linear foot (meter).
2. Basis of Payment: Includes excavation, backfill, bedding, thrust restraints, pipe and fittings.

## 1.3 COORDINATION

## A. Coordinate Work of this Section with connection to existing.

## 1.4 PREINSTALLATION MEETINGS

## A. Preinstallation Conference: Conduct conference at Project site.

## 1.5 SUBMITTALS

## A. Product Data:

1. Force mains.
2. PVC pipe.

## B. Shop Drawings:

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FORCE MAIN PIPING**

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1. Indicate piping piece numbers and locations.
  2. Indicate restrained joint locations.
  3. Signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for restrained joints, including establishing lengths of restrained joint piping required.
- D. Field Quality-Control Reports: For piping.
- E. Qualifications Statements: For manufacturer, installer, and licensed professional.
- 1.6 CLOSEOUT SUBMITTALS
- A. Project Record Documents: Record invert elevations and actual locations of pipe runs and connections.
- 1.7 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.
- B. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience.
- C. Licensed Professionals Qualifications: Professional engineer experienced in design of specified Work and licensed at Project location.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Storage:
1. Store materials according to manufacturer instructions.
  2. Do not place materials on private property without written permission of property owner.
  3. Do not stack pipe higher than recommended by pipe manufacturer.
- C. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  2. Store gaskets for mechanical and push-on joints in cool and dry location, out of direct sunlight, and not in contact with petroleum products.
  3. Provide additional protection according to manufacturer instructions.

**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS****A. Perform Work according to:**

1. The State of Colorado Department of Transportation standards.
2. The Municipality of Denver Department of Public Works standards.
3. standards.

**2.2 PVC PIPE****A. PVC Pressure Sewer Pipe and Fittings, 12-Inch (300-mm) Nominal Size and Smaller:**

1. Comply with ASTM D2241.
2. PVC 1220 (12454) or PVC 2120 (14333).
3. SDR: 26.

**2.3 MATERIALS****A. Bedding and Cover:**

1. Bedding: The bedding material shall be in accordance with item D-701-2.3 Bedding.
2. Cover: Reuse existing in place.
3. Soil Backfill from above Pipe to Finish Grade: Reuse existing in place.
4. Subsoil: Reuse existing in place.

**2.4 MIXES****A. Concrete: As specified in Item P-610.****2.5 ACCESSORIES****A. Pipe Markers: refer to 3.3 B). (5)****PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that excavation base is ready to receive Work.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**SECTION 333123.00 – SANITARY SEWARAGE**  
**FORCE MAIN PIPING**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
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- C. Verify that excavations, dimensions, and elevations are as indicated on Shop Drawings.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Correct over-excavation with fine aggregate.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- C. Remove large stones or other hard matter capable of damaging pipe or of impeding consistent backfilling or compaction.

### 3.3 INSTALLATION OF PIPING

- A. Bedding:
  - 1. Reuse bedding material at trench bottom.
  - 2. Maintain optimum moisture content of bedding material to attain required compaction density.
- B. Piping:
  - 1. Install pipe, fittings, and accessories as indicated on Drawings.
  - 2. Route piping in straight line.
  - 3. Install bedding at sides and over top of pipe to minimum compacted thickness of 8 inches.
  - 4. Backfilling and Compacting: (Reuse existing)
  - 5. Pipe Markers: Install detectable green warning tapes directly over piping and at outside edges of underground manholes.
- C. Thrust Restraints:
  - 1. Provide pressure pipeline with restrained joints or concrete thrust blocking at pumps, bends, tees, and changes in direction.
  - 2. Provide concrete thrust blocking of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than
  - 3. 2000 psi after 28 days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, place the base and thrust bearing sides of thrust blocks directly against undisturbed earth. Place the side of thrust blocks not subject to thrust against forms, if applicable. Provide the area of bearing as shown or as directed. Place blocking so that the fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.
- D. Cradles and Encasements: Reuse concrete cradles and encasements for pipelines where indicated on Drawings

**3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Request inspection by DEN PM on bedding prior to placing pipes.
- C. Pressure Testing:
1. Perform both a pressure test and a leakage test on all pipelines. Notify the DENPM at least 7 days in advance of equipment tests. Submit the final test report to the Contracting Officer within 30 days
  2. Pressure:
    - a. Not less than or 100 psi in excess of maximum static pressure, whichever is greater.
    - b. Maintain pressure within plus or minus 5 psi (34.4 kPa) of test pressure.
    - c. As indicated on Drawings.
  3. Time:
    - a. Conduct test for minimum of two hours.
  4. Initial Procedure:
    - a. Install corporation cocks at high points.
    - b. Slowly fill section to be tested with water, expelling air from piping at high points from air vents and by opening corporation cocks.
    - c. Close air vents and corporation cocks after air is expelled.
    - d. Raise pressure to specified test pressure.
  5. Testing:
    - a. Observe joints, fittings, and valves under test.
    - b. Remove and replace cracked pipes, joints, fittings, and valves showing visible leakage.
    - c. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
  6. Leakage:
    - a. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
    - b. Maximum Allowable Leakage:
      - 1)  $L = SD \times \text{sqrt}(P)/C$ .
      - 2) L = testing allowance, gph (L/h).
      - 3) S = length of pipe tested, feet (m).
      - 4) D = nominal diameter of pipe, inches (mm).
      - 5) P = average test pressure during hydrostatic test, psig (kPa).
      - 6) C = 148,000 (794 797).

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- c. If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
  - d. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
  - e. Correct visible leaks regardless of quantity of leakage.
- D. Perform pressure test on piping according to AWWA C605 standards.
- E. Compaction Testing:
- 1. Compaction testing per Item P-152.
- F. Prepare test and inspection reports.
- 3.5 PROTECTION
- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

#### **PART 4 - METHOD OF MEASUREMENT**

- 4.1 The length of pipe shall be measured in linear feet (m) of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. Each class, type and size of pipe shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured.

#### **PART 5 - BASIS OF PAYMENT**

- 5.1 These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, bedding, CLSM encasement, concrete encasement, backfill, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made at the contract unit price per linear foot for the following pipe installed complete in place, and accepted by the DEN PM:

Item 333123-5.1 8-Inch PVC DIW Force Main Pipe - per linear foot

**END OF SECTION 333123**

## ITEM L-100 LIGHTING AND ELECTRICAL WORK

### DESCRIPTION

**100-1.1 GENERAL.** The airfield electrical work to be done under this contract shall include the furnishing of all supervision, labor, materials, tools, equipment, and incidentals necessary to provide new airfield lighting system and other electrical work as shown on the drawings.

The electrical work shall comply with latest adopted editions, codes and standards applicable to this Contract as follows:

ICEA	Insulated Cable Engineers Association
ANSI C2	National Electrical Safety Code
ASTM	American Society of Testing and Materials
FAA	Advisory Circulars
FAA	Engineering Briefs
FAA	Orders
NECA	Standard for Installation
NEMA	Standard for Materials and Products
NFPA	National Electrical Code, 70
NFPA	Standard for Electrical Safety in the Workplace, 70E
NFPA	Life Safety Code, 101
OSHA	Occupational Safety and Health Administration, as Amended
UL	Underwriters Laboratories

All work shall be performed in strict accordance with these contract specifications, drawings, and any instructions that may be furnished by the DEN Project Manager during execution of the work to aid in interpretation of said drawings and specifications. Installation details and material and equipment specifications shall be in conformance with all applicable FAA Advisory Circulars, Orders and Engineering Briefs. The Contractor shall furnish written proof of FAA approval on all equipment covered by FAA specifications as part of the submittal package. The Contractor shall keep these specifications on file at their airport construction office.

**100-1.2 RELATED DOCUMENTS.** The general provisions of the contract apply to the work specified in Items L-100, L-108, L-109, L-110, L-115, L-125, L-140, and 13410A.

**100-1.3 SUMMARY OF WORK.** The work to be performed includes furnishing all labor, supplies, materials, equipment, transportation, and services required to augment, move, install, and complete electrical work as specified herein and as shown on the contract drawings.

The work includes, but is not limited to, the following:

**a.** Maintain in operation, all existing field electrical facilities and circuits while this improvement work is in progress, including protection of airport personnel, aircraft, and vehicles; furnish and maintain temporary circuits, and place augmented airport lighting into operation. Field lighting shall be operable each night, each day when fog conditions exist, , when the airport calls an emergency, or whenever the lighting system is deemed critical for use by Airport Operations or the FAA for safe operations of the airfield..

**b.** Provide underground cable (L-824) in accordance with specifications, at the locations shown on the plans. Test all circuit loops before and after installation of new cables to verify that no damage was caused by the Contractor.

**c.** Return to Owner or remove from the site, as directed by the DEN Project Manager, existing equipment that is to be removed or replaced.

**d.** Ground all equipment, enclosures, and conduits installed under this contract as shown on the plans, specifications or in accordance with the NEC whichever is more stringent.

**e.** Adjust finished grade as necessary to accommodate existing and new airfield equipment.

**f.** Other items required to complete foregoing. The omission of expressed reference to any parts necessary for or reasonably incidental to the complete installation shall not be construed as releasing the Contractor from furnishing and installing such parts.

**g.** In P-501 panel removal, asphalt removal or grading areas, the counterpoise conductor shall be tested prior to any work. The resistive value shall be documented and provided to the DEN Project Manager. At the completion of panel placement, the counterpoise shall be measured to be less than or equal to the value measured prior to demolition and witnessed by the DEN Project Manager. Counterpoise conductors shall be found to be continuous based on the resistive value (size and length) between locations such as light can to light can, manhole to light can, manhole to manhole, light can to ground rod, etc. Measurements shall be completed and demonstrated to the DEN Project Manager or designated representative before work is to proceed. Non-continuous counterpoise conductors shall be subject to removal of completed work and counterpoise repaired at no additional cost to the owner.

**h.** The Contractor shall inspect the conduit system prior to paving to assure the conduit is not damaged. The Contractor shall use an approved mandrel to proof the conduit system that runs through any panel replacement area; once panel replacement is completed the conduit shall have a mandrel pulled through the duct prior to re-installation of cable.

All items of general work required, such as excavation, cutting, patching, etc. shall be included in this Contract.

**100-1.4 WORK REQUIREMENTS.** The general work requirements are as follows:

- All work shall be scheduled to minimize the impact and duration of runway or taxiway shutdowns. The Contractor shall keep the DEN Project Manager informed of scheduled work which will affect existing equipment and operations. Minimum 10 working days advance notice shall be given to the DEN Project Manager and approval received for any disconnections or shutdowns.
- Existing lighting systems shall be operational at the end of each working day prior to nightfall except as permitted by the DEN Project Manager. Poor weather visibility or an emergency situation may require postponement of a scheduled shutdown on any given day.
- The plans are diagrammatic. Locations of equipment to be installed are shown in the plans, but the actual installation will depend on field conditions and the nature of the equipment furnished. When conditions which will adversely affect the installation become apparent, the DEN Project Manager shall be notified in writing.
- Locations and quantities of materials shown on the plans and in these specifications are approximate and shall be used for estimating purposes only. Actual locations and quantities of materials shall be reviewed by the Contractor through field investigation. No additional payment will be made for discrepancies between estimated quantities and locations of materials as shown in these documents and the actual field conditions.

The Contractor shall at all times keep the construction areas free from accumulations of waste material and rubbish, and prior to completion of work shall remove any rubbish from the project, as well as all tools, reels, equipment, and materials not a part of the project. Upon completion of the construction, the Contractor shall leave the work and premises in a clean, neat, and safe condition satisfactory to the DEN Project Manager. The Contractor shall be responsible for the proper performance in all respects, in whole and in part, of the electrical equipment and for the mechanical installation of electrical equipment until acceptance of the entire work by the DEN Project Manager.

**100-1.5 SUBMITTALS.** Submittals of all equipment and materials shall meet the requirements of Section 013300, Section 013325 and in accordance with this specification. Each submittal shall include no more than one spec section, i.e., each spec section shall be submitted under a separate submittal form as per Section 013300.

All materials and equipment used to construct this project shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Indicate all optional equipment and delete non-pertinent data. The Contractor is solely responsible for project delays accruing directly or indirectly from late submissions or resubmissions of submittals. This book shall include all fixtures and appropriate incidentals for each fixture to indicate to the DEN Project Manager that the Contractor comprehends the airfield lighting installation process.

The Contractor shall include wiring diagrams, cut sheets, brochures, etc. of all equipment used on the job, including, but not limited to the items listed in these specifications and in the format described herein. The submittal package will not be reviewed unless 100% complete.

The submittal shall consist of manufacturer's brochures and cut sheets describing the equipment and materials the Contractor plans to incorporate in the work. These sheets shall be sequentially ordered by specification number with the reference specification number shown on the bottom right of each sheet. Each cut sheet shall show the complete specification or drawing number with which the item must comply (i.e., L-108.2.03 and/or detail 3 on page EL-501). Clearly and boldly mark each copy to identify pertinent products or models applicable to this project.

In the one bound book, the cut sheets shall be organized by the specification item number (L-100, L-108, etc.) with a tabbed divider sheet separating each item section. The submitted cut sheet shall clearly show the equipment manufacturer's name, catalog number, size, type, and/or rating as required by these specifications or drawings by underlining or circling the information, highlighting is not acceptable. The conformance to FAA criteria or other standards where called for shall be clearly indicated for each item. Each sheet shall be dedicated to one piece of equipment, and all sheets shall be sequentially numbered (i.e., 1/50; indicating page 1 of 50 total pages). One manufacturer's cut sheet shall be submitted for each item. All sheets shall be 8-1/2" x 11" or 17" x 11". When these sizes are unpractical, a folded 24" x 36" drawing may be substituted. All drawings shall be to scale. All sheets shall be bound in a 3-ring binder. Each submittal shall show on the cover the complete job name and number, date, Contractor's name, and the words: "Electrical Submittal." The checklist shown in this specification shall be included as the first sheet of each submittal and shall show the page number of each item included in the submittal. Additional items to be submitted which are not on the list shall be added to the bottom of the table.

Samples of conduit, duct, fittings, cables, tapes, fixtures, etc., may be requested by the DEN Project Manager or required in these specifications. After they have been

reviewed, samples will be returned in tested condition to the Contractor. In the event any items of material or equipment contained in the list fail to comply with specification requirements, such items will be rejected. All rejected items shall be amended to meet the criteria and then resubmitted for approval by the DEN Project Manager.

Substitutions of materials referenced herein is allowed when "or equal" is referenced. Any substitution shall be included in the submittal package and contain additional information as required by Section 016000.

All methods and shop drawings of installations shall be submitted and approved prior to the start of installation for each phase of work.

Contractor's liability to the City, in case of variations in the submittal document from the requirements of the contract documents is not relieved by the City's review and acceptance of submittals containing variations unless the City expressly approves the deviations in writing, in which the City describes the variation.

**100-1.6 DRAWINGS.** The plans, which constitute an integral part of this Contract, shall serve as the working drawings. They indicate the extent and general layout of the lighting and signing system, arrangement of circuits, cables through ducts, and connections to existing circuit cables, and other work. Field verification of scale dimensions is required to determine actual locations, distances, and levels. The Contractor shall research in the field the exact routing and identification of all circuits which extend through, serve, or are affected by the area where work is to commence. No extra compensation will be allowed because of minor differences between work shown on the drawings and field conditions. The Contractor shall check the plans and specifications and, if any portion of the work is found to be omitted, unclear, or in error, the Contractor shall immediately notify the DEN Project Manager. The directions of the DEN Project Manager shall be followed and the work completed accordingly. The design drawings may be utilized in the preparation of the shop or working drawings showing the permanent construction, as described in L-100.

The plans and specifications are complementary and what is called for in either one shall be as binding as if called for in both.

Where a disagreement exists between the plans and specifications, the item or arrangements of better quality, greater quantity, or higher cost shall be included in the bid.

Any discrepancies between the drawings, Advisory Circulars, and field conditions must be resolved with the DEN Project Manager before proceeding. All agreements shall be verified in writing.

'Record' drawings covering equipment installed under previous contracts and which relate to this contract will be available for the Contractor. The airport cannot,

however, guarantee the accuracy of these drawings. Those conditions which will affect the work under this contract should be verified prior to any design/fabrication/installation commitment.

Detail dimensions shown on the plans are approximate and shall be field verified before construction. All differences shall be submitted to the DEN Project Manager in writing before construction begins.

**100-1.7 RECORD DRAWINGS.** The Contractor shall mark up a set of blue line prints to show the as-built conditions which differ from the contract plans. All changes shall be recorded by a skilled draftsman with at least three years of CAD experience. The DEN Project Manager will furnish a newly printed set of blue line drawings to be used for this purpose. Record drawings will be checked periodically for accurateness and partial payments will be withheld until the record drawings are completely updated. The mark-up set shall be kept at the site, and any changes, discoveries, or deviations shall be recorded daily. The Contractor shall furnish one newly printed as-built drawing set to the DEN Project Manager upon completion. This work shall be completed and accepted by the DEN Project Manager before approval of final payment. The Contractor shall include complete as-built drawings with Northing/Easting coordinates and elevations of duct banks installed. The Contractor shall document all return splice locations and complete wiring diagrams including the actual field configuration of circuits.

**100-1.8 MAINTENANCE AND OPERATING INSTRUCTIONS.** The Contractor shall provide the Owner with complete instructions in the proper care and operation of the equipment installed under this contract. This is considered as part of the final inspection, and final acceptance will not be given until the Owner's representative is knowledgeable about the system.

The Contractor shall also collect and assemble into each of three hardcover books and three CDs the installation details, instructions, parts list, source of local supply, schematics of actual equipment and operations, and directions supplied by the manufacturer with all equipment. If cut sheets are included showing various models and features of the equipment supplied, the specific model and features shall be clearly indicated to show only the options of the equipment that are actually provided and installed. Final acceptance of the work will be withheld until such data has been presented complete to the DEN Project Manager for transmission to the Owner. The Contractor shall comply with Section 017825 Operation and Maintenance Data.

The Contractor shall install all equipment according to the manufacturers' instructions and as shown in the drawings and specifications. The Contractor shall notify the DEN Project Manager in writing if any discrepancies exist between the aforementioned documents. Work shall be suspended until resolved and approval to proceed has been granted by the DEN Project Manager.

**100-1.9 SAFETY RULES.** The Electrical Safety Rules shall be observed and complied with in every detail, and any violation thereof shall be cause for immediate

termination of the Contractor's authority to proceed with the work and recourse to their Surety for completion of the Project. The Electrical Safety Rules are as follows:

The Contractor shall be responsible for conforming to the safety requirements of AC 150/5370-2, AC 150/5340-30, NFPA/NEC, as well as local building and electrical codes.

Electrical circuits, operating over 300 volts, phase-to-ground shall be de-energized before work is accomplished thereon. Work on energized systems shall be accomplished by trained personnel, properly insulated, and done with extreme caution.

Electrical circuits shall be considered de-energized only when one of the following conditions exists:

- Switches connecting subject circuit to the electrical supply are observed in the OPEN position, with an air break, and safety-tagged (padlocked) in the OPEN position;
- Electrically operated switches are visibly OPEN, blocked or racked in the OPEN position, and safety-tagged OPEN;
- Whenever the supply circuit breaker is not visible and clearly identified, the circuit shall be grounded. The ground connection shall be safety-tagged before work thereon, when the ground connection is not within sight of the work area.
- Oil switches observed OPEN in a sight window, and tagged OPEN; or oil fuse cutouts with fuse carrier removed and tagged OPEN.
- For airfield lighting circuits fed by constant current regulators, the disconnect switches feeding all affected regulators and power circuits leaving the vault shall be locked in the OPEN position. When working in manhole housings, additional circuits not a part of the project, those circuits shall be locked in the OPEN position as well. The circuits shall be put into maintenance lock out on the control system with the assistance of the project management team prior to lock out of the regulator.

**a. Use of Red Safety Tags:** Safety tags shall be filled out daily and connected to any switch or equipment opened for protection of personnel working upon circuits connected thereto.

Safety tags shall be removed only by the employee who placed the tag, or by another employee designated in writing by the employee who placed the tag, to remove the tag. Removal of a safety tag placed by an employee not available at the time of need to remove may be authorized by the Electrical Superintendent or his

designated representative, only after carefully checking that the circuit is ready to be energized.

Equipment with a safety tag attached shall not be operated, and connections with a safety tag attached shall not be changed.

Insulated cables, operated at over 300 volts to ground shall be handled, when energized, only with rubber gloves tested to 15,000 volts.

Insulated cables, which have been in operation, shall be cut only with grounded cable shears, or shall be grounded by driving a grounded sharp tool through the shielding and the conductors before cutting.

All personnel working around energized electrical equipment operating at over 600 volts shall wear standard insulated, non-conducting hard hats, and shall wear no garments with metallic zipper fasteners, and remove all jewelry.

Ladders used in any electrical work shall be of wood or fiberglass construction.

The Contractor shall designate a supervisor for all contract personnel and operations; said supervisor shall be present at the job site wherever contract operations are in progress.

## **EQUIPMENT AND MATERIALS**

**100-2.1 GENERAL.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified by independent laboratory testing to be in compliance with the specification, at the date of the Contractor's bid submission.

Equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the DEN Project Manager. Whenever Underwriters Laboratories has a published standard applicable to the equipment furnished for this contract, the furnished equipment shall be listed by UL. The term 'Equipment' shall be as defined in the NEC.

Materials and equipment shall be as specified herein. When materials are used that are not specifically designated herein, they shall be in accordance with the best industry standards and practices for equipment of this type. All components and parts shall be suitable for operation under the environmental conditions specified herein. Metal parts shall be either inherently corrosion-resistant or shall be suitably protected to resist corrosion or oxidation during extended service life.

**100-2.2 HARDWARE AND CORROSION PROTECTION.** In order to prevent deterioration due to corrosion, all bolts, nuts, studs, washers, pins, terminals, springs, hangers and similar fastenings and fittings shall be of an approved corrosion-resisting material and/or be treated in an approved manner to render it

adequately resistant to corrosion. All hardware such as cap screws, set screws, tap bolts, nuts, washers, etc., shall be of stainless steel type 304, SAE grade 2, if they are used outdoors unless specified otherwise on the plans. Brass, bronze, or hot-dip galvanized ferrous hardware (per ASTM, Specification A1530) will be considered for indoor use. All stainless steel and galvanized steel bolts, screws, nuts, etc., shall be coated with a layer of anti-seize compound.

All ferrous metalwork shall be hot-dip galvanized. If any galvanizing is damaged, the metal work shall be refinished by cleaning, treating with one coat of wash primer conforming to Federal (military) Specification MIL-P-152388, and shall be given one shop coat of zinc-rich base paint (zinc dust paint) conforming to Federal Specification TT-P-641F Type II, immediately when the wash primer is dry.

**100-2.3 PARTS RATING.** All parts shall be of adequate rating for the application and shall not be operated above the parts manufacturer's recommended ratings.

**100-2.4 ENVIRONMENTAL CONDITIONS.** The equipment installed outdoors shall be designated for continuous outdoor operation under the following environmental conditions unless specified elsewhere:

- a. Temperature: any ambient temperature from minus 20°F to plus 120°F.
- b. Altitude: 6000 MSL.
- c. Humidity: up to 100 percent.
- d. Sand and Dust: exposure to windblown sand and dust particles.
- e. Wind: operation at wind velocities up to 200 miles per hour.
- f. Water: components provided for underground installation, direct buried or installed in underground housing, shall be suitable for continuous operation, continuously or intermittently submerged in water.
- g. Chemical: shall be rated for exposure to all de-icing and anti-icing agents.

**100-2.5 SALVAGE.** Except as otherwise specified or indicated on the drawings, all electrical materials and equipment to be salvaged, removed, or "stored" shall become the property of the airport, and shall be moved by the Contractor to a site at the airport or within 5 miles of the airport designated by the DEN Project Manager. All wastes such as removed asphalt, concrete, excess dirt, conductors, damaged base cans, etc., shall become property of the Contractor and shall be disposed of off site by the Contractor.

**100-2.6 TESTING.** All materials and finishes are subject to testing. Material inspection and testing, and strength tests on the concrete will be performed by the Contractor at no expense to the airport other than material used. The Contractor shall assist the DEN Project Manager in obtaining samples during the course of construction work. The testing of electrical equipment shall conform to the description of the individual specification sections.

**100-2.7 INSPECTION.** Provide for electrical inspections by the DEN Project Manager. No work shall be concealed or enclosed until after inspections. If work is concealed or enclosed without inspection and approval, the Contractor shall be responsible for all expense and work required to open and restore the concealed area in addition to all required modifications.

Mill inspection will be waived, and the materials accepted upon certified copies of mill reports identifying the material specification requirements. Copies of order bills and test reports shall be furnished as requested.

**100-2.8 WARRANTY.** The Contractor shall provide a written 2-year warranty guaranteeing all work installed under this contract. It shall cover all parts and labor against defective parts, corrosion or workmanship necessary to repair or bring into proper operation any equipment including, but not limited to, isolation transformers, lamps, inset and elevated lighting fixtures, poles, conduit system, and junction boxes. This warranty work includes the Contractor to be on-site to remove, replace and ship any defective equipment discovered during the warranty period. At the end of the 2-year warranty period, the insulation resistance of each circuit shall be measured to a minimum of 750 Mohms according to the testing requirements per Item L-108. The warranty shall start upon the final acceptance of all work as accepted by the DEN Project Manager. Final payment will be withheld until receipt of the warranty by the DEN Project Manager.

LED fixtures shall have a written 4 year warranty provided as required by FAA Engineering Brief 67 (latest edition).

## **CONSTRUCTION METHODS**

**100-3.1 GENERAL.** Installation shall be performed by experienced and skilled persons to obtain only the best workmanship. All equipment shall be set square and true with construction. The work shall be under constant supervision by the Contractor, or by an authorized and competent foreman with five years airfield experience, until completion. The installation and adjustments shall be by competent Colorado State recognized licensed journeyman electricians. The Contractor shall include no more than one certified apprentice per journeyman electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.

All work shall be inspected by the Contractor's electrical QC. The electrical QC shall be responsible to correct or stop work when items of installation are found not to the

contract documents. The number of inspectors shall be adequate to cover all work areas during all phases of construction. The electrical QC inspector shall be submitted under the electrical QC Manager Plan, per Section 014310.

**100-3.2 INSTALLATION METHOD.** The methods used for the installation of electrical system and equipment shall conform to the National Electric Contractors Association (NECA) published "Standard of Installation" except where specifically specified or shown otherwise, and to the requirements of the National Electrical Code (NEC) and its revisions.

All electrical materials, construction methods, and installation shall be in accordance with applicable Federal Aviation Administration's advisory circulars including amendments, the National Electrical Code, and the American National Standards Institute Standard C2.

Workmanship shall be consistent with the best commercial practices for installation of this type. The workmanship shall be first class and in accordance with the highest standards of the electrical industry.

The responsibility for the correct and satisfactory installation and operation of all materials and equipment required herein shall rest with the Contractor. Before any equipment is ordered, a complete schedule of materials and detailed shop drawings covering all items of equipment and brochures of the materials proposed for installation shall be submitted for approval by the DEN Project Manager as described in Item L-100.

**100-3.3 SITE CONDITIONS.** At least five working days prior to commencing construction operations in an area which may involve underground utility facilities, the Contractor shall notify the DEN Project Manager and the owners of each underground utility facility shown on the plans. The FAA will assist the Contractor in locating FAA cables.

The existence of any known buried wires, conduits, junction boxes, ducts, or other facilities is shown in a general way only. It will be the duty of the Contractor, with the help of airport personnel, to visit the site and make exact determination of the existence and location of any facilities prior to commencing any work. It is understood that the Contractor will be responsible for making the exact determination of the location and condition of such facilities. Any costs shall be paid for by the Contractor. The Contractor shall obtain from the DEN Project Manager copies of contract drawings from previous construction projects, and examine these drawings and verify at the site the location of all below grade utilities in the vicinity of the work performed under this contract.

All items damaged by the Contractor's workers or equipment shall be replaced immediately at the Contractor's expense.

**100-3.4 INTERRUPTIONS.** Interruptions of lighting circuits may be necessary during construction. The Contractor shall provide a reliable shunt cable to provide temporary continuity of circuit service to runway and taxiway lights and signs during construction where required. The Contractor shall not interrupt any circuit or perform any work that might endanger any circuit until approval of the DEN Project Manager has been received. Temporary cables shall be installed in conduit and identified as a hazard.

The Contractor shall be responsible for installing, maintaining, protecting, and removing all required temporary jumper cables used to maintain power to electrical circuits.

For the permanent installation, all temporary connections and rerouting of circuits shall be replaced with new materials installed in accordance with the specifications and as shown on the plans.

See Item L-100, paragraph SAFETY RULES. Payment for this work will be made under Item L-108, Temporary Electrical Work/Jumpers when indicated. Otherwise the work shall be considered incidental.

If requested by the Project Manager, Contractor shall submit for approval an Operational Safety Plan (OSP) including circuits to be locked off and signs to be covered during construction.

**100-3.5 CODES.** The Contractor shall comply with all ordinances, laws, regulations, and codes applicable to the work involved and as referenced in these specifications. This does not relieve the Contractor from furnishing and installing work shown or specified which may be beyond the requirements of such ordinances, laws, regulations, and codes.

**100-3.6 SAFETY AREA.** The Contractor shall abide by the requirements of the contract specifications when working within the runway or taxiway safety areas or as directed by the DEN Project Manager.

### **METHOD OF MEASUREMENT**

**100-4.1** There shall be no separate measurement made for items in L-100. The work associated with the specification shall be considered incidental to other items of work.

### **BASIS OF PAYMENT**

**100-5.1** There shall be no separate payment made for items in L-100. The work associated with the specification shall be considered incidental to other items of work.

### **MATERIAL REQUIREMENTS**

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM L-100 LIGHTING AND ELECTRICAL WORK**

**DENVER INTERNATIONAL AIRPORT**  
**TAXIWAY DS EAST**  
**CONTRACT NO. 201737642-02**

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AC 150/5370-2      Operational Safety on Airports During Construction  
AC 150/5370-10    Standards for Specifying Construction of Airports  
MIL-P-152388      Wash Primer Specification  
TT-P-641F          Type II, Base Paint, Zinc-Rich

**END OF ITEM L-100**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-100 LIGHTING AND ELECTRICAL WORK**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## **Item L-108 Underground Power Cable for Airports**

### **DESCRIPTION**

**108-1.1** This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the DEN Project Manager. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

### **EQUIPMENT AND MATERIALS**

#### **108-2.1 General.**

**a.** Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the DEN Project Manager.

**c.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the DEN Project Manager) and replaced with materials that comply with these specifications at the Contractor's cost.

**d.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**e.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format. The DEN Project Manager reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 108-3.10e with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested in accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

**108-2.2 Cable.** Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge (AWG), L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type THWN-2, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

**108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods).** Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for grounding bond wire per ASTM B3 and ASTM B8, and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper-clad. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 10 feet (2.54 m) long and 3/4 inch (19 mm) in diameter.

**108-2.4 Cable connections.** In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

**a. The cast splice.** A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, "Scotchcast" Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.

**b. The field-attached plug-in splice.** Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall be in accordance with the manufacturer's requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

**c. The factory-molded plug-in splice.** Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

**d. The taped or heat-shrink splice.** Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer's recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

**108-2.5 Splicer qualifications.** Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the DEN Project Manager proof of the qualifications of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

**108-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**108-2.7 Flowable backfill.** Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**108-2.8 Cable identification tags.** Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

**108-2.9 Tape.** Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

**108-2.10 Electrical coating.** Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

**108-2.11 Existing circuits.** Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the DEN Project Manager. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the DEN Project Manager. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the DEN Project Manager. The Contractor shall record the results on forms acceptable to the DEN Project Manager. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

**108-2.12 Detectable warning tape.** Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

## **CONSTRUCTION METHODS**

**108-3.1 General.** The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Cable shall be run without splices, from fixture to fixture.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the DEN Project Manager or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the DEN Project Manager.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

**108-3.2 Installation in duct banks or conduits.** This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the DEN Project Manager of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the DEN Project Manager prior to any cable installation. If required by the DEN Project Manager, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the DEN Project Manager. Cable pull tensions shall be recorded by the Contractor and reviewed by the DEN Project Manager. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's

recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the DEN Project Manager, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

**108-3.3 Installation of direct-buried cable in trenches.** Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted.

Where cables must cross over each other, a minimum of 3 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

**a. Trenching.** Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

- When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.
- Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

The Contractor shall excavate all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill material may alternatively be used.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

**(1)** Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

**(2)** Trenching, etc., in cable areas shall then proceed, with approval of the DEN Project Manager, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

**b. Backfilling.** After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall encompass all cables ; be 3 inches (75 mm) deep, loose measurement; and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25.0 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent material. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be per the requirements of Item P-152.

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turving operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of per the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the DEN Project Manager. If not shown on the plans, the warning tape shall be located 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 3-6 inch (75 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 inches (200 mm) minimum below finished grade.

**c. Restoration.** Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the topsoiling, seeding, and mulching as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be to a minimum of 100 percent of ASTM D1557. Restoration shall be considered incidental to the pay item of which it is a component part.

**108-3.4 Cable markers for direct-buried cable.** The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10 - 15 cm) thick, extending approximately one inch (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (61 m)

along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word “CABLE” and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep. Stencils shall be used for cable marker lettering; no hand lettering shall be permitted.

At the location of each underground cable connection/splice, except at lighting units, or isolation transformers, a concrete marker slab shall be installed to mark the location of the connection/splice. The Contractor shall impress the word “SPLICE” on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the DEN Project Manager. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the DEN Project Manager. Furnishing and installation of cable markers is incidental to the respective cable pay item.

**108-3.5 Splicing.** Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

**a. Cast splices.** These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer’s instructions and to the satisfaction of the DEN Project Manager.

**b. Field-attached plug-in splices.** These shall be assembled per the manufacturer’s instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

**c. Factory-molded plug-in splices.** These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

**d. Taped or heat-shrink splices.** A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminants prior to application.

**e. Assembly.** Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

**108-3.6 Bare counterpoise wire installation for lightning protection and grounding.** If shown on the plans or included in the job specifications, bare solid [ #6 AWG ] copper counterpoise wire shall be installed for lightning protection of the underground cables. The DEN Project Manager shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

**a. Equipotential.** The counterpoise size is as shown on the plans. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches (200 mm) minimum or 12 inches (300 mm) maximum above the raceway or cable to be protected, except as permitted below:

**(1)** The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

**(2)** The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

**b. Isolation.** Not used

c. Common Installation requirements. When a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

**d. Parallel Voltage Systems.** Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

**108-3.7 Counterpoise installation above multiple conduits and duct banks.** Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

**108-3.8 Counterpoise installation at existing duct banks.** When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

**108-3.9 Exothermic bonding.** Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the DEN Project Manager. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the DEN Project Manager, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

a. All slag shall be removed from welds.

b. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See AC 150/5340-30 for galvanized light base exception.

c. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

**108-3.10 Testing.** The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the DEN Project Manager. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the DEN Project Manager. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

a. Earth resistance testing methods shall be submitted to the DEN Project Manager for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the DEN Project Manager. All such testing shall be at the sole expense of the Contractor.

b. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The DEN Project Manager shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the DEN Project Manager the following:

a. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.

b. That all affected circuits (existing and new) are free from unspecified grounds.

c. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than 2,000 megohms. Verify continuity of all series airfield lighting circuits prior to energization.

d. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.

e. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.

f. That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

g. That the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the DEN PROJECT MANAGER prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the DEN PROJECT MANAGER. Where connecting new cable to existing cable, insulation resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved “repair” procedures for items that have failed testing other than complete replacement.

### METHOD OF MEASUREMENT

**108-4.1** The cost of all excavation, backfill, dewatering and restoration regardless of the type of material encountered shall be included in the unit price bid for the work.

**108-4.2** Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet (meters) installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed in trench, duct bank or conduit. The measurement for this item shall include additional quantities required for slack.

**108-4.3** No separate payment will be made for ground rods.

**108-4.4** No separate measurement shall be made for green insulated ground conductor but shall be incidental to the installation of each phase/neutral conductor, as required.

### BASIS OF PAYMENT

**108-5.1** Payment will be made at the contract unit price for cable and counterpoise wire installed in duct bank, conduit, or trench, or cable including equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals, including ground rods and ground connectors and trench marking tape, necessary to complete this item.

Payment will be made under:

Item L-108-5.1	Install Cable, 1/C #8 AWG, FAA L-824, Type C, 5,000V – per linear foot
Item L-108-5.2	Install Bare Copper Counterpoise, #6 AWG, Including Connections/Terminations and Ground Rods – per linear foot
Item L-108-5.3	Install Cable, 1/C #6 AWG THWN-2, 600V – per linear foot
Item L-108-5.4	Install Cable, 1/C #4/0 AWG THWN-2, 600V – per linear foot

**REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## Advisory Circulars (AC)

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program

## Commercial Item Description

A-A-59544A	Cable and Wire, Electrical (Power, Fixed Installation)
A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

## ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

## Mil Spec

MIL-PRF-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

## National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems

## American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
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## Federal Aviation Administration Standard

FAA STD-019E	Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment
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**END OF ITEM L-108**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-108 UNDERGROUND POWER CABLE FOR AIRPORTS**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item L-109 Airport Lighting Vault Equipment

### DESCRIPTION

**109-1.1** This item shall consist of procurement and installation of constant current regulators, circuit selector switches, step-up transformers, and associated equipment installed in the airport lighting vault in accordance with this specification, any referenced specifications, and the applicable Federal Aviation Administration (FAA) Advisory Circulars (ACs). The equipment shall be installed at the locations and in accordance with the dimensions, layout, design, and details shown in the plans. This item shall include furnishing and installing all equipment, wiring, electrical busway equipment, circuit breakers, cable, conduit, grounding systems, cable connections, marking and labeling of equipment, labeling or tagging of wires, testing of the installation and all incidentals and appurtenances necessary to place the systems in operation as completed units to the satisfaction of the DEN Project Manager

### EQUIPMENT AND MATERIALS

#### 109-2.1 General.

**a.** Airport lighting equipment and materials covered by advisory circulars (AC) shall be certified in AC 150/5345-53, Airport Lighting Equipment Certification Program (ALECP) and listed in the ALECP Addendum.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the DEN Project Manager.

**c.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the DEN Project Manager) and replaced with materials that comply with these specifications at the Contractor's cost.

**d.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**e.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be provided in electronic pdf format, tabbed by specification section. The DEN Project Manager reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

### **INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING**

**109-3.1 General.** The Contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to ensure a complete and operable electrical distribution center for the airport lighting system as specified herein and shown in the plans. When specified, an emergency power supply and transfer switch shall be provided and installed.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction. All electrical work shall comply with the NEC and local code agency having jurisdiction including the separation of under 600V work from 5,000V work.”

**109-3.2 Contract Drawings.** Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed, even though some minor details are not shown, the Contractor shall furnish all equipment, material, and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation. Further, the Contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with the civil plans.

**120-3.3 Minor Departures.** Minor departures from exact dimensions shown on the electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensional item, provided contract requirements are met. The Contractor shall promptly obtain approval from the DEN Project Manager prior to undertaking any such proposed departure.

**109-3.4 Power supply equipment.** Transformers, regulators, booster transformers, and other power supply equipment items shall be furnished and installed at the location shown in the plans or as directed by the DEN Project Manager. The power supply equipment shall be set on steel “H” sections, “I” beams, channels, or concrete blocks to provide a minimum space of 1-1/2 inch (38 mm) between the equipment and the floor. The equipment shall be placed so as not to obstruct the oil-sampling plugs of the oil-filled units; and name-plates shall, so far as possible, not be obscured.

If specified in the plans and specifications, equipment for an alternate power source or an emergency power generator shall be furnished and installed. The alternate power supply installation shall include all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set shall be the size and type specified.

**109-3.5 Switchgear and panels.** Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items shall be furnished and installed at the location shown in the plans or as directed by the DEN Project Manager. Wall or ceiling mounted items shall be attached to the wall or ceiling with galvanized bolts of not less than 3/8-inch (9 mm) diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

**109-3.6 Duct and conduit.** The Contractor shall furnish and install square-type exposed metallic ducts with hinged covers for the control circuits in the vault. These shall be mounted along the walls behind all floor-mounted equipment and immediately below all wall-mounted

equipment. The hinged covers shall be placed to open from the front side with the hinges at the front bottom.

Wall brackets for square ducts shall be installed at all joints 2 feet (60 cm) or more apart with intermediate brackets as specified. Conduit shall be used between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors shall enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

**109-3.7 Wiring and connections.** The Contractor shall make all necessary electrical connections in the vault per the wiring diagrams furnished and as directed by the DEN Project Manager. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

**a. General.** Unless otherwise indicated, wiring shall consist of insulated copper conductors installed in RGSC or LFMC as shown on the Drawings. All neutral conductors shall extend from the neutral bus in the device where the active conductors originate. Device terminals for connection of more than one conductor shall be specifically designed for that purpose.

**b. Raceway System.** Minimum conduit size shall be 3/4-inch. Each run shall be complete, and shall be finished and swabbed before conductors are installed. Ends of conduit systems not terminated in boxes or cabinets shall be capped. Existing conduits shall be cleaned and swabbed before cables are pulled.

**(1) Field Cutting.** Where conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. The cut ends of the field-cut conduit shall be reamed to remove burrs and sharp edges. Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory cut threads on conduit. If field threaded conduits are to be installed underground, oil shall be cleaned from threads before applying a cold galvanizing compound. Conduits installed with threads not complying with these requirements shall be removed and replaced with conduits that comply.

**(2) Conduit Installation.** Conduit shall be installed parallel to or at right angles with the lines of the structures unless shown otherwise on the Drawings. Field bends shall be avoided where possible, but, where necessary, shall be made with an approved conduit-bending device. Radius of field bends shall be not less than 10 times the inside diameter of the conduit. Conduits shall be plugged during construction to prevent entrance of foreign material. Both ends of all conduits entering a junction box from below grade shall be sealed with a non-curable duct seal compound.

**(3) Rigid Galvanized Steel Conduit.** RGSC shall be used in all locations. All fittings for use with rigid galvanized steel conduit shall be of the threaded type of the same material as the conduit. Where conduits enter boxes or cabinets without threaded hubs, double locknuts shall be used plus an insulated metallic bushing on the open end.

**(4) Liquid tight Flexible Metal Conduit.** LFMC shall be used outdoors/indoors or in wet locations. Lengths of LFMC shall meet the requirements of the National Electrical Code. A separate ground conductor shall be provided across all flexible connections in addition to the green wire ground.

(5) Unapproved Conduit. Conduit systems such as flexible metal steel conduit, electrical non-metallic tubing, electrical metallic tubing, armored cable, and metal-clad cable shall not be allowed.

**c. Conductors.**

(1) Color-Coding. All branch circuit and feeder conductors shall be color coded as specified in the National Electrical Code (NEC). The color-coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable in any part of the installation. The equipment-grounding conductor shall be covered with green insulation or shall be bare copper as specified herein. Neutral conductors shall be continuous white unless more than one system is run in the same raceway, box, or other type enclosure. Where color-coding is not available in the larger size conductors (larger than #6 AWG), the conductors shall be color-coded by use of color-coded tape, half lapped for a minimum length of 3-inches. Where conductors are color-coded in this manner, they shall be color-coded in all junction boxes, outlets, and switches, as well as at all terminations.

(2) Conductor Identification. In addition to color coding, all line, phase, and neutral conductors shall be identified by self-laminating, self-sticking printed labels, permanently attached stamped metal foil markers, or equivalent means as approved by the DEN Project Manager. Panel and circuit numbers shall be identified. Conductor identification shall be provided at all terminations, and in all junction boxes through which these conductors pass.

In addition to color-coding, control circuit conductor identification shall be made by self-laminating, self-sticking printed labels, permanently attached stamped metal foil markers, or equivalent means as approved by the DEN Project Manager. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

**d. Quality Control Provisions.**

(1) Cable Tests. All cable testing shall be done by the Contractor in the presence of the DEN Project Manager. The Contractor shall provide all test equipment and power. Equipment shall have been calibrated within 2 years. Cables shall be tested in the following order: upon delivery to the site; again prior to installation; after each splice during installation; and again upon completion of backfill operations. The Contractor shall immediately report any physical defects detected by cable testing to the DEN Project Manager.

(a) 600-Volt Cable Test. After they are installed but prior to completion of final connections, conductors, splices, and insulation shall be tested at not less than 500 volts DC for one minute. The minimum resistive value shall be 30 megohms between conductors and between conductors and ground.

(b) Control Cable Tests. Control cables shall be tested at not less than 500 volts DC for one minute. The minimum resistive value between conductors and from each conductor to grounded shield shall be 50 megohms.

(2) Failure of Cable Under Test. Cable failing tests prior to installation shall not be installed. Cables which pass the initial upon delivery testing, but fail after the Contractor takes possession shall be repaired or replaced by the Contractor at no additional cost.

**(3) Ground Resistance Test.** When new equipment is being installed, the existing grounding electrode system for each airfield electrical vault shall be tested. Ground resistance of the ground rod system shall not exceed 10 ohms. Ground resistance measurements shall be made in normally dry weather and not less than 72 hours after rainfall. If the desired resistance value is not obtained, additional rods shall be driven at least 10-feet apart until resistance values are obtained. Testing shall be by "fall of potential" method of IEEE 81 using Fluke, Biddle, Megger, or equivalent earth testers.

**(4) Quality Assurance.** All electrical equipment and materials provided by the Contractor shall be in accordance with this specification and be approved by Underwriters' Laboratories (UL), Inc. Original and two copies of tabulated results of all cable tests and ground resistance test performed under this section shall be forwarded to the DEN Project Manager for approval.

**109-3.8 Marking and labeling.** All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

**a. Wire identification.** The Contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification -markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4 inch (19 mm) in diameter and not less than 1/32 inch (1 mm) thick. Identification markings designated in the plans shall be stamped on tags by means of small tool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

**b. Labels.** The Contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the DEN Project Manager. The letters and numerals shall be not less than one inch (25 mm) in height and shall be of proportionate width. The Contractor shall also mark the correct circuit designations per the wiring diagram on the terminal marking strips, which are a part of each terminal block.

**120-3.9 Grounding.** The grounding system for the facility shall be as indicated on the contract Drawings and as specified herein. The NEC, except where otherwise indicated hereinafter, shall govern, but in no case shall the Code be violated.

**a. Equipment Grounding Conductor.**

**(1)** All metallic non-current carrying parts of electrical equipment shall be grounded with an equipment-grounding conductor whether or not shown on the drawings. The equipment-grounding conductor shall be a green insulated copper conductor unless otherwise indicated. When this conductor is not sized, or not shown on the drawings, it shall be sized in accordance with the applicable sections of the NEC and in no case shall it be smaller than #10 AWG.

**(2)** The equipment grounding conductor shall be connected to the grounded conductor in the busway. The equipment ground shall be securely bonded to the existing ground bus located behind each CCR lineup.

**b. Other Grounding System.** Any additional grounding system used for electronic equipment shall be connected directly to the exterior earth electrode system unless otherwise indicated on the drawings. Other grounding systems shall not be used in place of the equipment grounding conductor system.

**120-3.10 Constant Current Regulator.** Constant Current Regulator (CCR) shall conform to Specifications for L-829 CCRs set forth in FAA Advisory Circular 150/5345-10, latest edition. Regulators shall be individual, stand-alone units. The CCRs shall be air-cooled, dry type, ferro-resonant with internally mounted CCR/ALCMS interface unit and insulation resistance monitoring. The input power for all regulators shall be 60 Hz, 480V single phase, size as shown on the Plans. The output power shall be rated 6.6A, as shown on the Plans.

Regulators associated with taxiway centerline light circuits shall be equipped with five brightness steps, 2.8/3.2/4.1/5.2/6.6A. The regulators shall be equipped with an integral contactor for primary switching. The regulators shall have switches for remote/local function switch, local ON/OFF, and all brightness steps. The regulator must be capable of operation on 'local' control without the remote control cable connected and capable of local operation for emergency if remote switch or leads become inoperative.

Regulators shall have a direct reading, digital output RMS ammeter of +/-1 percent accuracy and a digital output RMS voltmeter of +/-1 percent accuracy. The regulator shall have automatic input voltage compensation for -5 to +10 percent variations.

Each regulator shall have integral input and output lightning protection. Output lightning arrestors shall be of the distribution type, door knob and similar type lightning arrestors are not acceptable.

Each CCR shall be provided with door safety interlocks with a maintenance bypass position. The interlock shall be wired to turn the CCR off should the door be opened.

Each CCR shall be provided with a metal drawing pocket for the instruction book. A laminated wiring diagram and troubleshooting charts shall be provided for each regulator, attached to the door interior or located in the metal drawing pocket.

Each CCR shall be provided with a metal nameplate with the following data stamped into the nameplate:

Input: \_\_\_\_\_ Volts \_\_\_\_\_ Hertz \_\_\_\_\_ Amperes

Control: \_\_\_\_\_ Volts \_\_\_\_\_ Hertz

Output: \_\_\_\_\_ kW at \_\_\_\_\_ Amperes

Output Current: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

FAA-L-829 Serial No. \_\_\_\_\_

Constant Current Regulators must be compatible with the existing ALCMS and exactly duplicate all monitoring and control functions that currently exist at the Airfield Lighting Vault.

Dry-contacts within the regulator shall be supplied for the following information:

- a. Brightness Step of CCR
- b. Loss of Input Power to CCR
- c. Incorrect Output Current
- d. Remote/Local Status
- e. Number of Lamp Failures (Accurate to one (1) lamp) (4 contacts coded in binary form 1,2,4,8)
- f. Overcurrent
- g. Open Circuit

#### h. Low VA

Regulators shall have internal distributive control equipment and monitoring devices for ALCMS interface (ADB ACE 3). The control equipment will be supplied power from the save source as the ALCMS.

**120-3.11 Testing.** This section describes the testing and demonstrations furnished by the Contractor. All items furnished and/or installed by the Contractor shall be tested and demonstrated in accordance with these specifications, the FAA advisory circulars, and the manufacturer's recommendations. All equipment and labor required for testing and demonstrations shall be furnished by the Contractor.

a. Fully test the installation by continuous operation for a period of not less than seventy-two (72) hours as a completed unit, prior to acceptance by the Owner.

b. Up to two (2) walk-throughs may be initiated by the DEN Project Manager during which the airfield lighting equipment would be required to be in operation. Additional walk-throughs may be necessary depending upon the number of discrepancies found on the previous walk-throughs.

c. The Contractor is responsible for lamp replacements and necessary maintenance of airfield items during the testing, construction and walk-through periods.

d. Test airfield lighting circuit cabling per Item L-108, Underground Power Cable for Airports.

e. Demonstrate all features and functions of all systems and instruct the Owner's personnel in the proper and safe operation of the systems.

f. The Contractor shall perform the necessary inspection and tests for some items concurrently with the installation because of subsequent inaccessibility of some components. The DEN Project Manager shall be notified by the Contractor forty-eight (48) hours in advance of any testing. There are no approved "repair" procedures for items that have failed testing other than complete replacement.

Any other corrective measures are prohibited unless approved in writing by the DEN Project Manager.

### **METHOD OF MEASUREMENT**

**109-4.1** The quantity of constant current regulators, series circuit cutouts, or other equipment to be paid for under this item shall be measured per each piece of equipment furnished and installed complete in place, ready for operation, and accepted by the DEN Project Manager. The price for this item shall include removal and disposal of existing equipment, as detailed on the plans. Also included is furnishing and installing circuit breakers, wire, conduit, bus duct connections, series circuit cutout, conduit, anchor bolts, mounting hardware, framing, and all other incidentals, materials, and labor required to complete the installation to the satisfaction of the DEN Project Manager.

### **BASIS OF PAYMENT**

**109-5.1** Payment will be made at the contract unit price for each completed and accepted vault equipment item. This price shall be full compensation for furnishing all materials and for all

preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item L-109-5.1      Install 5kW CCR with Internal ACE – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
AC 150/5345-49	Specification L-854, Radio Control Equipment;
AC 150/5345-53	Airport Lighting Equipment Certification Program

#### American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/ICEA S-85-625	Standard for Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements
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#### ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C62	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C90	Standard Specification for Loadbearing Concrete Masonry Units
ASTM D2823	Standard Specification for Asphalt Roof Coatings, Asbestos Containing
ASTM D4479	Standard Specification for Asphalt Roof Coatings – Asbestos-Free

#### Commercial Item Description (CID)

A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation) Institute of Electrical and Electronic Engineers (IEEE)
IEEE 1584	Guide for Performing Arc-Flash Hazard Calculations

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-109 AIRPORT LIGHTING VAULT EQUIPMENT**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**Master Painter’s Institute (MPI)**

MPI Reference #9 Alkyd, Exterior, Gloss (MPI Gloss Level 6)

**Underwriters Laboratories (UL)**

UL Standard 6 Electrical Rigid Metal Conduit – Steel

UL Standard 514B Conduit, Tubing, and Cable Fittings

UL Standard 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL Standard 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

UL Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit

**National Fire Protection Association (NFPA)**

NFPA-70 National Electrical Code (NEC)

NFPA-70E Standard for Electrical Safety in the Workplace

NFPA-780 Standard for the Installation of Lightning Protection Systems

**END OF ITEM L-109**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-109 AIRPORT LIGHTING VAULT EQUIPMENT**

**DENVER INTERNATIONAL AIRPORT  
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## **Item L-110 Airport Underground Electrical Duct Banks and Conduits**

### **DESCRIPTION**

**110-1.1** This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

### **EQUIPMENT AND MATERIALS**

#### **110-2.1 General.**

**a.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the DEN Project Manager.

**b.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the DEN Project Manager. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the DEN Project Manager and replaced with materials, that comply with these specifications, at the Contractor's cost.

**c.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The DEN Project Manager reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

**110-2.2 Steel conduit.** Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10-mil thick coat of asphaltum sealer or shall have a factory-bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mils of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions. In lieu of PVC coated RGS, corrosion wrap tape shall be permitted to be used where RGS is in contact with direct earth."

**110-2.3 Plastic conduit.** Plastic conduit and fittings shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10. [SEP]
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

- a. Type I—Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.
- b. Type II—Schedule 40 PVC suitable for either above ground or underground use.
- c. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.
- d. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

**110-2.4 Split conduit.** Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

**110-2.5 Conduit spacers.** Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads. They shall be designed to accept No. 4 reinforcing bars installed vertically.

**110-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**110-2.7 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another DEN Project Manager approved third party certification program. Precast concrete structures shall conform to ASTM C478.

**110-2.8 Flowable backfill.** Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**110-2.9 Detectable warning tape.** Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), orange (telephone/fiber optic cabling) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

## **CONSTRUCTION METHODS**

**110-3.1 General.** The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The DEN Project Manager shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. Under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade; in other locations, the top of the duct bank or underground conduit shall be not less than 18 inches (0.5 m) below finished grade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor's expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the DEN Project Manager of any blockage in the existing ducts.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200-pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

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Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill may alternatively be used

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the DEN Project Manager. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the DEN Project Manager, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Additional duct bank supports shall be installed, as approved by the DEN Project Manager.

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion per federal, state, and local requirements is incidental to Item L-110. Unless otherwise specified, excavated materials that are deemed by the DEN Project Manager to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the DEN Project Manager and compacted per Item P-152.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables) cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no

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splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

a. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

b. Trenching, etc., in cable areas shall then proceed with approval of the DEN Project Manager, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

**110-3.2 Duct banks.** Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor shall space the conduits not less than 3 inches (75 mm) apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the DEN Project Manager for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater

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than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the DEN Project Manager shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the DEN Project Manager.

**110-3.3 Conduits without concrete encasement.** Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch (6.3 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the DEN Project Manager for review prior to use.

**110-3.4 Markers.** The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

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The Contractor shall impress the word “DUCT” or “CONDUIT” on each marker slab. Impression of letters shall be done in a manner, approved by the DEN Project Manager, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the DEN Project Manager. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the DEN Project Manager. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

**110-3.5 Backfilling for conduits.** For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the DEN Project Manager.

**110-3.6 Backfilling for duct banks.** After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 “Excavation and Embankment” except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of Item P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet (76 m) of duct bank or one work period’s construction, whichever is less.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the DEN Project Manager.

**110-3.7 Restoration.** Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include topsoiling, seeding, and mulching shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

**110-3.8 Ownership of removed cable.** All removed wire and cable shall become property of the Contractor and shall be removed off site. Removal of wire and cable shall be considered

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incidental to installation of new wire and cable. No separate payment will be made for removal of wire and cable.

### **METHOD OF MEASUREMENT**

**110-4.1** Underground conduits and duct banks shall be measured by the linear feet (meter) of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated material, and restoration, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

### **BASIS OF PAYMENT**

**110-5.1** Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material, and, for drain lines, the termination at the drainage structure. This price shall be full compensation for removal and disposal of existing duct banks and conduits as shown on the plans, furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

Payment will be made under:

Item L-110-5.1	Install 1-Way, 2-Inch PVC Duct (CLSM) – per linear foot
Item L-110-5.2	Install 1-Way, 3-Inch PVC Duct (CLSM) – per linear foot
Item L-110-5.3	Install 1-Way, 2-Inch PVC Duct (CE) – per linear foot
Item L-110-5.4	Install 1-Way, 3-Inch PVC Duct (CE) – per linear foot
Item L-110-5.5	Install 2-Way, 2-Inch PVC Ductbank (CE) – per linear foot
Item L-110-5.6	Install 2-Way, 2-1/2-Inch PVC Ductbank (CE) – per linear foot
Item L-110-5.7	Install 2-Way, 4-Inch PVC Ductbank (CE) – per linear foot
Item L-110-5.8	Install 4-Way, 4-Inch PVC Ductbank (CE) – per linear foot

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circular (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
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National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
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Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit - Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 1242	Electrical Intermediate Metal Conduit Steel
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

**END OF ITEM L-110**

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## Item L-115 Electrical Manholes and Junction Structures

### DESCRIPTION

**115-1.1** This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the DEN Project Manager. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the DEN Project Manager.

### EQUIPMENT AND MATERIALS

#### 115-2.1 General.

**a.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the DEN Project Manager.

**b.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the DEN Project Manager) and replaced with materials that comply with these specifications at the Contractor's cost.

**c.** All materials and equipment used to construct this item shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The DEN Project Manager reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

**e.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

**115-2.2 Concrete structures.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures shall be as shown on the plans.

**115-2.3 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand 200,000 lb aircraft loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the DEN Project Manager shall be submitted by the Contractor to allow for a full evaluation by the DEN Project Manager. The DEN Project Manager shall review per the process defined in the General Provisions.

**115-2.4 Junction boxes.** Junction boxes shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a L-894 blank cover, gasket, and stainless steel hardware. All bolts, studs, nuts, lock washers, and other similar fasteners used for the light fixture assemblies must be fabricated from 316L (equivalent to EN 1.4404), 18-8, 410, or 416 stainless steel. If 18-8, 410, or 416 stainless steel is utilized it shall be passivated and be free from any discoloration. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868. All junction boxes shall be provided with both internal and external ground lugs.

**115-2.5 Mortar.** The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

**115-2.6 Concrete.** All concrete used in structures shall conform to the requirements of Item P-610, Concrete for Miscellaneous Structures.

**115-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**115-2.7 Frames and covers.** The frames shall conform to one of the following requirements:

- a. ASTM A48      Gray iron castings
- b. ASTM A47      Malleable iron castings
- c. ASTM A27      Steel castings
- d. ASTM A283, Grade D      Structural steel for grates and frames
- e. ASTM A536      Ductile iron castings
- f. ASTM A897      Austempered ductile iron castings

All castings specified shall withstand a maximum tire pressure of 250 psi and maximum load of 200,000 lbs.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word "ELECTRIC" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a "DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

**115-2.8 Ladders.** Ladders, if specified, shall be galvanized steel or as shown on the plans.

**115-2.9 Reinforcing steel.** All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

**115-2.10 Bedding/special backfill.** Bedding or special backfill shall be as shown on the plans.

**115-2.11 Flowable backfill.** Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**115-2.12 Cable trays.** Cable trays shall be of plastic. Cable trays shall be located as shown on the plans.

**115-2.13 Plastic conduit.** Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

**115-2.14 Conduit terminators.** Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

**115-2.15 Pulling-in irons.** Pulling-in irons shall be manufactured with 7/8-inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

**115-2.16 Ground rods.** Ground rods shall be one piece, copper clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet (2.4 m) long nor less than 5/8 inch (16 mm) in diameter.

## CONSTRUCTION METHODS

**115-3.1 Unclassified excavation.** It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the DEN Project Manager without additional expense to the Owner.

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The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the DEN Project Manager. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the DEN Project Manager. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the DEN Project Manager. Structures shall be placed after the DEN Project Manager has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the DEN Project Manager as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

**115-3.2 Concrete structures.** Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the DEN Project Manager before the concrete is placed.

**115-3.3 Precast unit installations.** Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

**115-3.4 Placement and treatment of castings, frames and fittings.** All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the DEN Project Manager and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is

granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the DEN Project Manager and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor's expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

**115-3.5 Installation of ladders.** Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

**115-3.6 Removal of sheeting and bracing.** In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The DEN Project Manager may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

**115-3.7 Backfilling.** After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the DEN Project Manager.

Backfill shall not be placed against any structure until approval is given by the DEN Project Manager. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the DEN Project Manager establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the DEN Project Manager may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

**115-3.8 Connection of duct banks.** To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

**115-3.9 Grounding.** A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm)

diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtailed shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

**115-3.10 Cleanup and repair.** After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer's recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

**115-3.11 Restoration.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

**115-3.12 Inspection.** Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

**115-3.13 Manhole elevation adjustments.** The Contractor shall adjust the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor shall be responsible for determining the exact height adjustment required to raise or lower the top of each manhole to the new elevations. The existing top elevation of each manhole to be adjusted shall be determined in the field and subtracted/added from the proposed top elevation.

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The Contractor shall remove/extend the existing top section or ring and cover on the manhole structure or manhole access. The Contractor shall install precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or shall cut the existing manhole walls to shorten the existing structure, as required by final grades. The Contractor shall reinstall the manhole top section or ring and cover on top and check the new top elevation.

The Contractor shall construct a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab shall conform to the dimensions shown on the plans.

**115-3.14 Duct extension to existing ducts.** Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

### **METHOD OF MEASUREMENT**

**115-4.1** Electrical manholes and junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering; sheeting and bracing; all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections; and ground rod testing

**115-4.2 Manhole elevation adjustments** shall be measured by the completed unit installed, in place, completed, and accepted. Separate measurement shall not be made for the various types and sizes.

### **BASIS OF PAYMENT**

**115-5.1** The accepted quantity of electrical manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

**115-5.2** Payment shall be made at the contract unit price for manhole elevation adjustments. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary, including but not limited to, spacers, concrete, rebar, dewatering, excavating, backfill, topsoil, sodding and pavement restoration, where required, to complete this item as shown in the plans and to the satisfaction of the DEN Project Manager.

Payment will be made under:

Item L-115-5.1      Install Electrical Handhole – per each

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

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**American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)**

ANSI/IEEE STD 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

**Advisory Circular (AC)**

AC 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits

AC 150/5345-26 Specification for L-823 Plug and Receptacle, Cable Connectors

AC 150/5345-42 Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories

AC 150/5340-30 Design and Installation Details for Airport Visual Aids

AC 150/5345-53 Airport Lighting Equipment Certification Program

**Commercial Item Description (CID)**

A-A 59544 Cable and Wire, Electrical (Power, Fixed Installation)

**ASTM International (ASTM)**

ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application

ASTM A47 Standard Specification for Ferritic Malleable Iron Castings

ASTM A48 Standard Specification for Gray Iron Castings

ASTM A123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products

ASTM A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A536 Standard Specification for Ductile Iron Castings

ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A897 Standard Specification for Austempered Ductile Iron Castings

ASTM C144 Standard Specification for Aggregate for Masonry Mortar

ASTM C150 Standard Specification for Portland Cement

ASTM C206 Standard Specification for Finishing Hydrated Lime

**FAA Engineering Brief (EB)**

EB #83 In Pavement Light Fixture Bolts

**Mil Spec**

MIL-P-21035 Paint High Zinc Dust Content, Galvanizing Repair

**National Fire Protection Association (NFPA)**

NFPA-70 National Electrical Code (NEC)

**END OF ITEM L-115**

## Item L-125 Installation of Airport Lighting Systems

### DESCRIPTION

**125-1.1** This item shall consist of airport lighting systems furnished and installed in accordance with this specification, the referenced specifications, and the applicable advisory circulars (ACs). The systems shall be installed at the locations and in accordance with the dimensions, design, and details shown in the plans. This item shall include the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the DEN Project Manager.

### EQUIPMENT AND MATERIALS

#### 125-2.1 General.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified under the Airport Lighting Equipment Certification Program in accordance with AC 150/5345-53, current version. FAA certified airfield lighting shall be compatible with each other to perform in compliance with FAA criteria and the intended operation. If the Contractor provides equipment that does not perform as intended because of incompatibility with the system, the Contractor assumes all costs to correct the system for to operate properly.

**b.** Manufacturer's certifications shall not relieve the Contractor of their responsibility to provide materials in accordance with these specifications and acceptable to the DEN Project Manager. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the DEN Project Manager and replaced with materials, which do comply with these specifications, at the sole cost of the Contractor.

**c.** All materials and equipment used shall be submitted to the DEN Project Manager for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Clearly mark each copy to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be clearly made with arrows or circles (highlighting is not acceptable). The Contractor shall be responsible for delays in the project accruing directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the DEN Project Manager, to determine compliance with the plans and specifications. The Contractor's submittals shall be submitted in electronic PDF format, tabbed by specification section. The DEN Project Manager reserves the right to reject any or all equipment, materials or procedures, which, in the DEN Project Manager's opinion, does not meet the system design and the standards and codes, specified herein.

**e.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. All LED

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light fixtures must be warranted by the manufacturer for a minimum of 4 years after date of installation inclusive of all electronics.

### **EQUIPMENT AND MATERIALS**

**125-2.2 Conduit/Duct.** Conduit shall conform to Specification Item L-110 Airport Underground Electrical Duct Banks and Conduits.

**125-2.3 Cable and Counterpoise.** Cable and Counterpoise shall conform to Item L-108 Underground Power Cable for Airports.

**125-2.4 Tape.** Rubber and plastic electrical tapes shall be Scotch Electrical Tape Numbers 23 and 88 respectively, as manufactured by 3M Company or an approved equal.

**125-2.5 Cable Connections.** Cable Connections shall conform to Item L-108 Installation of Underground Cable for Airports.

**125-2.6 Retroreflective Markers.** Not required.

**125-2.7 Runway and Taxiway Lights.** Runway and taxiway lights shall conform to the requirements of AC 150/5345-46. Lamps shall be of size and type indicated, or as required by fixture manufacturer for each lighting fixture required under this contract. Filters shall be of colors conforming to the specification for the light concerned or to the standard referenced.

#### **Lights**

<b>Type</b>	<b>Class</b>	<b>Mode</b>	<b>Style</b>	<b>Base</b>	<b>Filter</b>	<b>Transformer</b>	<b>Notes</b>
L-852C(L)	2	1	3	L-868B	Green	Per Mfg	Heater Kit
L-852D(L)	2	1	3	L-868B	Yellow	Per Mfg	Heater Kit
L-852K(L)	2	1	3	L-868B	Green	Per Mfg	Heater Kit
L-852T(L)	2	1	3	L-868B	Blue	Per Mfg	Heater Kit
L-861T(L)	N/A	1	N/A	L-867B	Blue	Per Mfg	Heater Kit

**125-2.8 Runway and Taxiway Signs.** Runway and Taxiway Guidance Signs should conform to the requirements of AC 150/5345-44. Signs shall be equipped with a weatherproof on/off toggle switch. The switch shall be located on the end-panel of the sign adjacent to the power leg. The switch shall be protected from driving rain and icing. The switch shall de-energize the sign so that maintenance work can be performed safely.

In addition, ID tags shall be installed on all new signs. ID tags shall consist of 2" high yellow text on a black background. Tags shall be constructed of UV resistant phenolic material and shall be attached to the side of the sign closest to the taxiway pavement using stainless steel screws or pop rivets. Circuit name and sign identifier shall be engraved on tags as shown on the Plans.

### Signs

Type	Size	Style	Class	Mode	Notes
L-858Y(L)	3	5	2	2	LED
L-858L(L)	3	5	2	2	LED

**125-2.9 Runway End Identifier Light (REIL).** Not required.

**125-2.10 Precision Approach Path Indicator (PAPI).** Not required.

**125-2.11 Circuit Selector Cabinet.** Not required.

**125-2.12 Light Base and Transformer Housings.** Light Base and Transformer Housings should conform to the requirements of AC 150/5345-42. Light bases shall be Type L-867 or L-868, Class 1A, Size B shall be provided as indicated or as required to accommodate the fixture or device installed thereon. Base plates, cover plates, and adapter plates shall be provided to accommodate various sizes of fixtures.

**125-2.13 Isolation Transformers.** Isolation Transformers shall be Type L-830, size as required for each installation. Transformer shall conform to AC 150/5345-47.

**125-2.14 Cementitious Grout.** For use in the installation of ID markers. The cementitious grout shall be non-shrink, non-metallic and contain no chloride. When mixed to a fluid state, the typical compressive strength shall reach 5,800 psi in 28 days, and positive expansion. The grout shall meet the requirements of ASTM C1107 and ASTM C827.

**125-2.15 Silicone Grease.** Designed for application on rubber O-rings installed between flange rings and light fixtures. The grease shall consist of a composition of polydimethylsiloxane and fumed silica. The grease shall be moisture resistant, prevent corrosion/oxidation, and have a service temperature range of -40°F to +400°F.

**125-2.16 Base Can Sealant.** For application between the top of a load bearing base can and spacer rings and/or spacer rings and bottom of flange ring with pavement dam. The 100% silicone sealant shall be non-shrink.

## INSTALLATION

**125-3.1 Installation.** The Contractor shall furnish, install, connect and test all equipment, accessories, conduit, cables, wires, buses, grounds and support items necessary to ensure a complete and operable airport lighting system as specified here and shown in the plans.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and state and local code agencies having jurisdiction.

The Contractor shall install the specified equipment in accordance with the applicable advisory circulars and the details shown on the plans.

**125-3.2 Testing.** All lights shall be fully tested by continuous operation for not less than 24 hours as a completed system prior to acceptance. The test shall include operating the constant current regulator in each step not less than 10 times at the beginning and end of the 24-hour test. The fixtures shall illuminate properly during each portion of the test.

**125-3.3 Shipping and Storage.** Equipment shall be shipped in suitable packing material to prevent damage during shipping. Store and maintain equipment and materials in areas

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protected from weather and physical damage. Any equipment and materials, in the opinion of the DEN Project Manager, damaged during construction or storage shall be replaced by the Contractor at no additional cost to the owner. Painted or galvanized surfaces that are damaged shall be repaired in accordance with the manufacturer's recommendations.

**125-3.4 Elevated and In-pavement Lights.** Water, debris, and other foreign substances shall be removed prior to installing fixture base and light.

A jig or holding device shall be used when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Light fixtures shall be oriented with the light beams parallel to the runway or taxiway centerline and facing in the required direction. The outermost edge of fixture shall be level with the surrounding pavement. Surplus sealant or flexible embedding material shall be removed. The holding device shall remain in place until sealant has reached its initial set.

### **METHOD OF MEASUREMENT**

**125-4.1** Taxiway lights will be measured by the number of each type installed as completed units in place, ready for operation, and accepted by the DEN Project Manager. Guidance signs will be measured by the number of each type and size installed as completed units, in place, ready for operation, and accepted by the DEN Project Manager.

### **BASIS OF PAYMENT**

**125-5.1** Payment will be made at the Contract unit price for each complete taxiway light or guidance sign, installed by the Contractor and accepted by the DEN Project Manager. This payment will be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

Payment will be made under:

Item L-125-5.1	Install L-852C(L) Bidirectional Taxiway Centerline Light – per each
Item L-125-5.2	Install L-852D(L) Unidirectional Taxiway Centerline Light – per each
Item L-125-5.3	Install L-852K(L) Bidirectional Taxiway Centerline Light – per each
Item L-125-5.4	Install L-852T(L) Taxiway Edge Light – per each
Item L-125-5.5	Install L-861T(L) Taxiway Edge Light – per each
Item L-125-5.6	Install L-868B Cover Plate – per each
Item L-125-5.7	Install L-868B Base Can (22" Deep) in Concrete Pavement – per each
Item L-125-5.8	Install L-867B Base Can (Adjustable Depth) in Asphalt Pavement – per each
Item L-125-5.9	Install L-858(L) Guidance Sign, 3 Module – per each
Item L-125-5.10	Install L-858(L) Guidance Sign, 4 Module – per each
Item L-125-5.11	Install L-858 Guidance Sign Panels – per each
Item L-125-5.12	Install Guidance Sign Foundation, 3 Module – per each

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Item L-125-5.13	Install Guidance Sign Foundation, 4 Module – per each
Item L-125-5.14	Cover Taxiway Edge Light – per each
Item L-125-5.15	Install Shorting Plug – per each
Item L-125-5.16	Cover Guidance Sign – per each
Item L-125-5.17	Instll L-858(L) Guidance Sign, 2 Module – per each
Item L-125-5.18	Install Guidance Sign Foundation, 2+3 Module – per each

### REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### Advisory Circulars (AC)

AC 150/5340-18	Standards for Airport Sign Systems
AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems
AC 150/5345-39	Specification for L-853, Runway and Taxiway Retroreflective Markers
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5345-44	Specification for Runway and Taxiway Signs
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures
AC 150/5345-47	Specification for Series to Series Isolation Transformers for Airport Lighting Systems
AC 150/5345-51	Specification for Discharge-Type Flashing Light Equipment
AC 150/5345-53	Airport Lighting Equipment Certification Program

#### Engineering Brief (EB)

EB No. 67	Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures
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**END OF ITEM L-125**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-125 INSTALLATION OF AIRPORT  
LIGHTING SYSTEMS**

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**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## Item L-140 Field Photometric Testing

### DESCRIPTION

**140-1.1 General.** Photometric testing of airfield lighting systems shall be performed by a firm with demonstrated capability for the field measurement of the photometric performance of airfield lighting fixtures. The firm shall have experience in evaluating the test results against FAA standards and manufacturers' performance criteria. The firm shall demonstrate its capability by having performed similar work successfully at no less than ten (10) international air carrier airports in the past five (5) years. Suggested contacts for this service shall be as follows or approved equal.

Lean Engineering  
17752 Mitchell N, Suite C  
Irvine, CA 92614  
Phone: (949) 502-8687  
Email: dlean@LeanCorp.com

Navaid Lighting Associates, Inc.  
141 Autumn Glenn Road  
Saltillo, MS 38866  
Phone: (662) 869-8655  
Fax: (662) 869-0065  
Cell: (662) 322-6418  
Email: david@navaidlighting.com

Photometric testing shall be performed at night between one hour after sunset and one hour before sunrise, with minimum interference to airport operations. Within 24 hours before starting the test, the Contractor shall clean all the light fixtures within the testing schedule to assure that the system is ready for photometric testing. The Contractor shall also verify calibration of constant current regulator output using a true root-mean-squared (RMS) ammeter prior to the testing.

A list of equipment to be used for the photometric testing shall be submitted. In addition, a record of experience on similar projects with references for future contact shall be submitted.

**140-1.2 Testing Requirements.** The testing shall be performed on all taxiway (new or reinstalled) centerline light fixtures installed as part of this project. No testing is required for elevated taxiway edge lights.

The photometric test equipment shall consist of an array of sensors capable of taking simultaneous light readings as the equipment moves away from a light source. There shall be no loss of accuracy at speeds allowed by the Airport.

The system shall be capable of accurately tracking the position of each sensor relative to the specified main beam area of each fixture type being measured.

The system shall be capable of automatically calculating the average intensity (in candela) in the main beam and 10 percent beam areas to estimate the vertical and horizontal beam alignment (in degrees) by identifying the brightest part of the light beam being measured.

The system shall log the data while testing commences, display the results and identify locations where the minimum average main beam intensities are below the levels listed in FAA AC 150/5345-46 and/or the main beam is mis-aligned either vertically or horizontally.

The system shall log the GPS coordinates for each light fixture while each test is being run.

A print out or electronic copy of the test readings will be made available periodically during the progress of the testing.

The measurements shall be compared to FAA standards as presented in FAA AC 150/5345-46. The calculated averages shall be not less than the minimum average intensities specified in the Advisory Circular in order for the fixture to be considered acceptable.

If any of the calculated average readings is below the specified minimum average intensity, or if any individual reading is below fifty percent (50%) of the specified minimum average intensity, additional sets of readings shall be taken as required to identify the problem(s) with the fixture in question.

**140-1.3 Test Reports.** Initial reports will be submitted periodically during the progress of the work so that corrective measures may be taken as may be required. If the corrective measures are promptly made, the fixtures involved will be reevaluated during the scheduled period of field testing to assure that proper performance has been achieved.

The final test results shall be documented in a Final Report, with six (6) copies submitted to the Airport. The Final Report shall present an evaluation of each fixture tested. For those fixtures that do not meet the performance requirements, the Final Report shall include proposed corrective measures, such as cleaning or replacement of lenses, re-aiming of fixture including resetting of base can, grinding of pavement, repair/replacement of fixture, or any combination of issues. Allowance of the light output to 70% of the minimum average intensity as recommended by AC 150/5340-26, Maintenance of Airport Visual Aid Facilities, will not be accepted for new fixture installations. The final test results for existing light fixtures will indicate which fixtures do not meet the performance requirements in addition to the light output level being below 70% of the minimum average intensity listed in AC 150/5345-46.

The Final Report shall include the following:

- a. Performance Bar Chart for each runway or taxiway system, such as Runway 34R centerline or Runway 16L touch down zone. This provides a visual indication of overall performance for the service and identifies the relative position of sub-standard fixtures.
- b. Colour Iso-candela diagrams of fixture light output for representative fixtures that have failed due to low light output or mis-alignment.

**c.** Photometric test data tabulated with the following information:

Fixture Number	First and last fixture in a series as shown on the Plans
Light Direction	Direction/orientation of light beam
Max CD	Maximum candela output in a point along the main beam
Avg. CD	Average candela on fixture being tested
Lens Color	Color of lens on fixture being tested

**d.** Max Sensor Reading Sensor number (on the sensor bar) that provides the maximum reading.

**140-1.4 Spares.** As part of this work the contractor shall have on-hand a minimum of 10 percent of additional light fixtures of every type to replace deficient fixtures as a result of the photometrics. This material shall be on-hand during the testing so that the light fixtures can be replaced during the test, and the fixtures retested at once. Any deficient fixtures shall be sent to the manufacturer for replacement and replenished back to the airport. The warranty shall commence after the photometric testing is complete and all fixtures passed. Unused fixtures shall become the property of the airport.

**140-1.5 Corrective Action.** The Contractor shall be responsible for correcting any deficient condition identified as a result of the photometric testing. If retesting of corrected conditions can be completed within the originally scheduled field test period, then retesting shall be performed to verify that any deficient condition has been successfully corrected. If retesting is required after the scheduled photometric testing period, additional costs to test corrected fixtures shall be borne by the Contractor.

### **METHOD OF MEASUREMENT**

**140-2.1** Taxiway light photometric testing shall be measured as lump sum for all taxiway semi-flush lights verified as correct and ready for operation, with documentation submitted to and accepted by the DEN Project Manager. These costs shall include any new lights required to meet photometric requirements and any retesting of lights as required.

### **BASIS OF PAYMENT**

**140-3.1** Payment will be made at the contract unit price per lump sum for completed and approved testing of lights. This price shall include all labor, equipment, tools, and materials necessary to complete the work specified, including retesting of new fixtures found to be deficient in the initial testing and corrected by the Contractor. Any photometric retesting shall be paid by the Contractor and is incidental to the installation of the lighting systems.

Payment shall be made as follows:

Item L-140-3.1	Photometric Testing – per lump sum
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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
ITEM L-140 FIELD PHOTOMETRIC TESTING**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**END OF ITEM L-140**

## **Item 13410A Airfield Lighting Control and Monitoring System Modifications**

### **DESCRIPTION**

#### **13410A-1.1 Project Scope.**

This specification details the scope for the manufacturer of the ALCMS, ADB-Safegate:

- a.** Provide new functionality, preset table, graphic changes for the new CCR.
- b.** Verify wiring and operation of the new CCRs. Provide wiring diagrams and parts list to all bidding contractors.
- c.** Modify ALCMS to accommodate reconfiguration of circuits as shown on drawings. Reconfigure the ALCMS and presets accordingly and submit new ALCMS Demonstration CD accordingly.
- d.** Additionally CCRs shall require new control wire to/from each CCR to the ALCMS computer cabinet.
- e.** Provide the following equipment:
  - (1) 20 kW CCRs w/ Internal Ace Unit
  - (2) Control wire for new CCRs as required.
- f.** All bidding contractors shall get the same price.
- g.** The work shall include all supervision, labor, software, programming, materials, tools, equipment, testing of the installation, manual updates, and all incidentals necessary to provide a fully functional and complete system to the satisfaction of the DEN Project Manager.
- h.** Maintain a fully functional and operational airport lighting control system throughout the modification and testing of the affected system components. Coordinate construction with the DEN Project Manager to avoid conflicts with airport operational requirements and to schedule required system outages.
- i.** Provide a 1 year maintenance warranty agreement which shall include the furnishing of key spare parts along with technical support on a 24 hour/ 7 day week/ 365 day year both remote and on site.

#### **13410A-1.2 Submittal.**

- a.** Equipment and software submittals shall meet the requirements listed in Item L-100, Lighting and Electrical Work. The Supplier shall submit the complete dimensional and performance characteristics, system block diagram, wiring schematic diagrams and installation and operation instructions. The block diagram shall reflect the total integration of all new digital

and analog devices into the existing system. The diagram shall reference all interconnection cabling requirements for digital components of the system including any data communications links.

**b.** All significant equipment to be supplied shall be listed, followed by descriptive data sheets. The equipment list shall include each component name, supplier, model number, a description of the operation, quantity supplied and any special setup, operation and maintenance characteristics.

**c.** Software submittals shall provide a complete description of the system on a functional level.

**d.** Submittals of graphic displays shall include color pictorial representations of all runway and taxiway operations above 1200' RVR, between 1200' and 500' RVR, and below 500' RVR, including SMGCS operations affected by this project.

**13410A-1.3 Operation and Maintenance Manuals.** The supplier shall provide revision pages for eight existing operation and maintenance manuals. The manual revisions shall be easy-to-understand and contain detailed instructions and well-diagrammed procedures for operations and systems maintenance. The supplier shall also upload accurate, legible system drawings in document libraries in all ALCMS maintenance computers.

**13410A-1.4 Warranty.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of twenty-four (24) months or the manufacturer's standard guarantee period whichever is greater, from final acceptance by the DEN Project Manager. Any defective materials and/or equipment shall be repaired or replaced, at the DEN Project Manager's discretion, with no additional cost to the Owner.

**13410A-1.5 Testing.**

**a. General:**

(1) All elements of the ALCMS system affected by work associated with this project shall be tested to demonstrate that the total system satisfies all of the functional requirements of this Specification.

(2) As a minimum, the testing shall include the following:

**(a)** Software Implementation Tests (SIT).

**(b)** Operational Acceptance Tests (OAT).

**(c)** Functional Acceptance Tests (FAT).

(3) Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the systems or subsystems producing the correct result (effect), the specific test requirement will have been satisfied.

(4) All tests shall be conducted in accordance with, and documented on, prior Owner-approved procedures, forms, and checklists. Each specific test to be performed shall be

described and a space provided after it for signoff by the appropriate party after its satisfactory completion.

- (5) Copies of these signoff test procedures, forms, and checklists will constitute the required test documentation.
- (6) Provide all special testing materials and equipment. Perform tests using actual system variables, equipment, and data.
- (7) Coordinate all testing with the Owner.
- (8) The Owner will actively participate in many of the tests. The Owner reserves the right to test or retest any and all specified functions whether or not explicitly stated in the prior-approved Test Procedures.
- (9) The Owner's decision shall be final regarding the acceptability and completeness of all testing.

**b. Software Implementation Tests (SIT):**

- (1) The new software shall be installed on one of the existing ALCMS for testing and to demonstrate that the proposed system components will function through the reconfigured software.
- (2) Tests shall demonstrate all newly installed or reinstalled hardware and software components function to the satisfaction of the Owner. As a minimum the tests shall include the following from AC 150/5345-56, Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS), latest edition:
  - (a) 10.6.1 Communication Link Test
  - (b) 10.6.3 Tower Remote Control Test
  - (c) 10.6.4 Requesting and Granting Control
  - (d) 10.6.5 Preset Failsafe System Test
  - (e) 10.9.3 Initiating a Low Visibility Test
  - (f) Operational state of the remote Circuit Selector Switch test.

**c. Operational Acceptance Tests (OAT):**

- (1) At the completion of the SIT, the system shall be made available to the Owner's personnel for hands-on operational testing. The system shall be completely usable and available for the OAT.
- (2) The OAT will run for a period of 2 days. Coordinate all tests and provide assistance for any simulations needed with the Owner. The supplier shall be on site for the duration of the tests. The OAT shall be performed for both the primary and secondary ALCMS.

(3) At the end of the OAT, the Owner, and Contractor shall coordinate and address any discrepancies found during the OAT.

(4) All discrepancies shall be taken care of prior to the start of the FAT.

**d. Functional Acceptance Tests (FAT):**

(1) Once the system has completed the OAT, a witnessed Functional Acceptance Test shall be performed on the complete ALCMS to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph and site-by-site basis.

(2) Updated versions of the documentation shall be made available to the Owner at the jobsite both before and during the tests. In addition, one copy of an O&M Manual shall be made available to the Owner at the jobsite both before and during testing.

(3) The daily schedule called for under paragraph SIT shall also be followed during the FAT.

**13410A-1.6 Onsite Services.**

**a. General:**

(1) Provide experienced personnel and management onsite to coordinate and effect, for modifications to the Airfield Lighting Control and Monitoring System:

- (a) Installation, termination, and adjustment.
- (b) All onsite testing.
- (c) Startup assistance.

**b. Onsite Supervision:**

(1) Provide onsite, an experienced resident engineering manager to supervise and coordinate all of the onsite Airfield Lighting Control and Monitoring System activities. This resident engineering manager shall be onsite during the total period required to effect all of the required onsite activities relating to the Airfield Lighting Control and Monitoring System modification.

**c.** Attend planning meetings (2 of them) as required.

**d. Testing Team:**

(1) Provide, onsite, a team of experienced engineering and technician personnel during the total period required to:

(a) Thoroughly check the installation, termination, and adjustment of all of the Subsystems and their components affected by this project.

(b) Perform and complete all onsite tests.

(c) Provide assistance to the Owner for a period of one calendar week after interim and final acceptance inspections.

**13410A-1.7 Project Conditions.**

a. This project is located on an active airport and work is subject to security and other restrictions.

b. The airport will be operational during construction and requires coordination and prior approval from the resident engineer for any planned power and systems outages. All work inside the airport security fence shall be coordinated with the DEN Project Manager.

c. The existing airport lighting control system shall remain operational during construction and testing of the system modifications. The existing control system configuration shall remain operational until the DEN Project Manager accepts the new system modifications.

**13410A-1.8 Hardware for Procurement.**

a. CCRs

b. Any modifications or additional hardware required to the computer rack to accommodate the new CCRs.

**13410A-1.9 Software Procurement**

a. Modifications to airfield graphics and demonstration CD.

**CONSTRUCTION REQUIREMENTS**

**13410A-2.1** In the event that a communication or software adjustment or defective equipment requires repair or replacement, testing may be suspended or continued at the sole discretion of the DEN Project Manager. Prior tests shall be verified to still meet the project requirements before continuing if testing is suspended.

**13410A-2.2** If the need for further adjustments of any kind becomes evident during inspection or demonstration, the supplier shall continue work until the installation operates properly.

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**TECHNICAL SPECIFICATIONS**  
**DIVISION 2 – AIRFIELD STANDARDS**  
**ITEM 13410A – AIRFIELD LIGHTING CONTROL AND**  
**MONITORING SYSTEM MODIFICATIONS**

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### **METHOD OF MEASUREMENT**

**13410A-3.1** ALCMS modification shall be measured for payment as lump sum for providing services, material and coordinating the update of the existing ALCMS computer to reflect changes associated with this project, testing, coordination, site support, as-built, and all other appurtenances and accessories required for a fully functional system in place, ready for operation and accepted by the DEN Project Manager as described in drawings. This bid item shall also include furnishing any material such as wire, cable, and parts required to add the new CCRs to the existing ALCMS. Bid item shall be paid once upon completion of all commissioning and testing is performed and accepted by the DEN Project Manager. This bid item shall include all taxes, overhead, and profit.

**13410A-3.2** Furnishing constant current regulators shall be bid under a separate bid item under L-109.

### **BASIS OF PAYMENT**

Payment will be made at the lump sum unit price for ALCMS modifications.

Payment will be made under:

Item 13410A-5.1      Airfield Lighting Control System Modifications – per lump sum

**END OF ITEM 13410A**

**SECTION 260400 - BASIC ELECTRICAL REQUIREMENTS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.
- B. Where a panel is installed, at least 25% of panel capacity, accounting for serving panel capacity, shall remain as spare capacity after project completion.
- C. Related Sections:
  - 1. Basic Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 General Requirements, and Divisions 27 and 28.
  - 2. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 26.
  - 3. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the Contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.
  - 4. Temporary Power: See Division 1 for construction power constraints.
- D. REFERENCE STANDARDS
- E. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- F. Latest editions of the following:
  - 1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Department).
  - 2. International Fire Code (as amended by the Denver Fire Department).
  - 3. International Building Code (as adopted and amended by the Denver Building Department).
  - 4. International Energy Conservation Code (as adopted and amended by the

- Denver Building Department).
5. ANSI/IEEE C2 - National Electrical Safety Code.
  6. OSHA - Occupational Safety and Health Administration, as Amended
  7. Underwriter's Laboratory (UL).
  8. National Fire Protection Association (NFPA).
  9. Other references as listed elsewhere in these specifications.
  10. IEEE Standard 519- Recommended Practices and Requirement for Harmonic Control in Electrical Power Systems.

### 1.3 DEFINITIONS

- A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
- B. "Install": To erect, mount and connect complete with related accessories.
- C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Wiring": Raceway, fittings, wire, boxes and related items.
- F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
- G. "Or Equal. Or Approved Equal": Refers to products that, in the opinion of the DEN Project Manager, are similar in all respect to products specified by proprietary brand name.
- H. "Exposed": Not installed underground or "concealed" as defined above.
- I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.
- J. "Similar" or "Equal": Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
- K. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to DEN Project Manager.
- L. "Related Work" includes all "Work" required for a complete working system.
- M. "Equipment": A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.
- N. "Busbar": A rigid metallic conductor, lug or bar used to make a common connection

between more than one circuit. (Includes all termination assemblies.)

- O. "Shall": Mandatory requirements of this specification are characterized by the use of the word "shall".
- P. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this Project.

#### 1.4 WORK SEQUENCE

- A. Construct Work in sequence under provisions of Division 1 where applicable.

#### 1.5 DRAWINGS AND SPECIFICATIONS

- A. The Drawings indicate the general arrangement of circuits, outlets, panelboards and other work. Information shown on the Drawings is schematic; however, re-circuiting will not be permitted without specific acceptance. In cases of conflict between specifications and drawings, the specification shall have precedence. Data presented on the drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all of the Contract Documents and adjust all work to conform to all conditions shown therein.
- B. Prior to submitting a bid, a site visit is required to ascertain all conditions affecting the proposed installation and to adjust all work accordingly. Costs for providing for these adjustments, including response to site constraints, shall be itemized and listed in the bid proposal.
- C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the DEN Project Manager in writing 72 hours before the date of bid opening. In the event such discrepancies exist, and the DEN Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the DEN Project Manager.

#### 1.6 COORDINATION

- A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.
- B. Any electrical work penetrating concrete walls or floors shall require saw cutting and/or core drilling and shall require approval by the DEN Project Manager. The Contractor shall perform all necessary imaging (x-rays, etc.) as specified, and submit shop drawings of any saw cutting or core drilling to the DEN Project Manager prior to performing the Work. Refer to Section 017330 "Cutting and Patching" for additional

requirements.

- C. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

## 1.7 COORDINATION DRAWINGS

- A. Where the Contractor modifies the design, through selection of equipment differing from that shown, coordination drawings shall be provided by the Contractor in accordance with Division 1 to a scale of 1/4"=1'0" or larger for equipment rooms, details, congested areas and sections; other plans at a scale of 1/8"=1'0". These drawings are to detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components.
- B. Coordination drawings shall be in accordance with current DEN standards for format, and as outlined in Division 1.
- C. The Contractor shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Indicate the proposed locations of raceway systems, equipment, and materials. Include the following:
    - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    - b. Exterior wall and foundation penetrations.
    - c. Fire-rated wall and floor penetrations.
    - d. Equipment connections and support details.
    - e. Sizes and location of required concrete pads and bases.
    - f. Support details.
  - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
  - 3. Floor plans, elevations, and appropriate details are required to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

## 1.8 SUBMITTALS

- A. Refer to Section 013300 "Submittal Procedures".
- B. Submit shop drawings, coordination drawings and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 260400 – BASIC ELECTRICAL REQUIREMENTS**

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- C. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with Contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
- D. Clearly mark each shop drawing as follows for purposes of identification:
1. Shop Drawing.
  2. Equipment Identification Used on Contract Drawings.
  3. Date.
  4. Name of Project.
  5. Branch of Work.
  6. Project Manager's Name.
  7. Contractor's Name.
- E. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the Contract document schedules. Contractor agrees that submittals processed by the DEN Project Manager are not change orders; that the purpose of submittals is to demonstrate to the DEN Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material the Contractor intends to furnish and install and by detailing the installation methods the Contractor intends to use.
- F. Contractor shall be responsible for dimensions (which the Contractor shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of the Contractor's Work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.
- G. Maintain one copy of accepted shop drawings at the Project field office until completion of the Project, and make this copy available, upon request, to representatives of the DEN Project Manager and Owner.
- H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action by the DEN Project Manager accepting their use.
- I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this Project.
- 1.9 RECORD DOCUMENTS
- A. Maintain a Contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of

drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the DEN Project Manager at all times. Upon completion of the Contract, this set of record drawings shall be delivered to the DEN Project Manager. Follow current DEN BIM standards, to be furnished to the successful bidder as well as the project-specific BIM execution plan. Record documents to be provided by the Contractor shall clearly and accurately show the following:

1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

#### 1.10 REGULATORY REQUIREMENTS

- A. Obtain all permits, plan review, and inspections from authority having jurisdiction.
- B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than the drawings and specifications.

#### 1.11 ENVIRONMENTAL CONDITIONS

- A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:
  1. Location: Indoors/Outdoors.
  2. Altitude: 5,500 feet above sea level.
  3. Temperature range: -30°F to 120°F.

#### 1.12 WARRANTY

- A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two (2) years, or any longer period specifically noted elsewhere in these specifications, from date of substantial completion.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS AND EQUIPMENT

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- A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.
- B. All equipment and materials installed shall be new, unless otherwise specified.
- C. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the DEN Project Manager or Owner and at no additional cost to the Owner.
- D. All electrical "equipment" and assemblies shall be acceptable for installation only if labeled and listed by a nationally recognized testing laboratory, such as UL or an equivalent.
- E. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

## 2.2 STORAGE AND PROTECTION

- A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.
- C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

## 2.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only:
  - 1. Any product meeting those standards.
- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions:
  - 1. Submit a request for substitution for any manufacturer not specifically named with supporting documentation for approval by DEN Project Manager.

## 2.4 PRODUCTS LIST

- A. Within fifteen (15) days after date of Notice to Proceed, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

**2.5 SUBSTITUTIONS**

- A. Refer to Division 1 General Requirements, Section 012510 "Substitutions".

**PART 3 - EXECUTION****3.1 WORKMANSHIP**

- A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of Work, as determined by the DEN Project Manager, are not acceptable and shall be corrected at the contractors cost.
- B. Contractor shall include no more than one apprentice per Journeyman Electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.
- C. Any changes or deviations from the drawings and specifications must be accepted in writing by the DEN Project Manager. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- D. Upon completion of Work, all equipment and materials shall be installed complete, thoroughly tested, checked, correctly adjusted, and left ready for intended use or operation. All Work shall be thoroughly cleaned and all residues shall be removed from surfaces. Exterior surfaces of all material and equipment shall be left in a perfect, unblemished condition.
- E. Contractor shall provide a complete installation, including all required labor, material, cartage, testing, insurance, permits, and taxes.

**3.2 CHASES, OPENINGS, CUTTING AND PATCHING**

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the DEN Project Manager. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and shall be pre-approved by the DEN Project Manager.
- B. All penetrations required through completed concrete construction shall be core drilled at minimum size required. All penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete.

**3.3 ELECTRICAL INSTALLATIONS**

- A. Coordinate electrical systems, equipment, and material installation with other building components. If the Contractor furnishes equipment of a different size, the Contractor shall furnish and install the proper fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner, and as deemed acceptable by the DEN Project Manager.

**3.4 PROGRESS OF WORK**

- A. Coordinate the progress of electrical work to conform to the progress of the Work of the other trades. Complete the entire installation as soon as the condition of the sites will permit. Any cost resulting from defective or ill-timed work performed under Division 26 shall be borne by the Contractor.

**3.5 ELECTRICAL COMPLETION**

- A. Training of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.

1. Instruction shall be given when the particular system is complete, shall be of the number of hours indicated, and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

- B. Operating and Maintenance Manuals and Parts Lists: Deliver three (3) complete operating & maintenance manuals and parts lists in three-ring binders to the Owner at the time of the above required training. The information shall be provided on the manufacturer's original data sheets. Fully explain the contents of the manuals as part of required training and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.

1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.

- C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications for all applicable equipment furnished and installed as part of this Contract. Submit three (3) copies of test reports to the DEN Project Manager for the DEN Project Manager's approval.

- D. Clean Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Clean all electrical equipment, such as switchboards, panel boards,

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luminaries etc. of construction dirt, dust, etc. and touch-up or repaint all scratches, blemishes, rust spots etc. to its original condition. Any costs to the Owner for cleanup of the site will be charged against the Contractor.

- E. Acceptance Demonstration: Upon completion of the Work, at a time to be designated by the DEN Project Manager, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided or modified under this Contract.
- F. Final Acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment, as approved by DEN Project Manager.

**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. Basic Electrical Requirements shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 260400**

**SECTION 260510 - TESTING, ACCEPTANCES AND CERTIFICATION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY OF REQUIREMENTS**

- A. The Contractor shall provide the necessary field-testing and startup services for all electrical and mechanical equipment except as noted otherwise. The field-testing and startup services shall be in accordance with each equipment manufacturer's written recommendations for field-testing proving they meet Contract standards.
- B. The Contractor shall be responsible for furnishing all equipment, power source when needed, coordinating and performing electrical/electronic testing required by the Contract Documents. Testing requirements may be located on the Contract Drawings or other sections of the specifications.
- C. The Contractor shall provide all necessary assistance and cooperation with any Independent Testing Organization furnishing by the City. The Contractor shall correct, repair, or replace all equipment found to be defective by the Independent Testing Organization.

**1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of other requirements of these Specifications, all Work specified herein shall conform to or exceed the applicable requirements of the referenced Standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer's written recommendations:
  - 1. Building Code and DEN Standards.
  - 2. ANSI/IEEE C2 - National Electrical Safety Code.
  - 3. OSHA - Occupational Safety and Health Administration, as Amended
  - 4. NETA - National Electric Testing Association
  - 5. NEMA ICS 1 - General Standards for Industrial Control and Systems.
  - 6. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
  - 7. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
  - 8. UL 1008 - Standard for Automatic Transfer Switches.
  - 9. NFPA 70 - National Electrical Code, including but not limited to use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702.

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10. NFPA 72 - National Fire Alarm Code (as adopted and amended by the Denver Building Code and DEN Standards).
11. NFPA 101 - National Electrical Safety Code (as adopted and amended by the Denver Building Code and DEN Standards).
12. NFPA 110 - Standard for Emergency and Standby Power Systems (as adopted and amended by the Denver Building Code and DEN Standards).
13. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
14. NEMA Standard ICS-2-447 - AC Automatic Transfer Switches.
15. IEC - Standard for Automatic Transfer Switches.

**1.4 SUBMITTALS**

- A. Comply with Division 1 submittal requirements.
- B. Five (5) copies of complete certified test reports shall be submitted to the DEN Project Manager by the contractor. Electronic copy of test reports in pdf format to also be submitted to the DEN Project Manager. The test reports shall include the following as a minimum:
  1. Power cable high potential test reports:
    - a. Insulation resistance tests.
    - b. Continuity tests.
  2. Transformer test reports to include where applicable:
    - a. Transformer turns ratio.
    - b. Winding resistance.
    - c. Insulation power factor.
    - d. K Factor.
  3. All electrical/electronic equipment and systems functional test report.
  4. All other reports required by individual specification sections.

**PART 2 - PRODUCTS****2.1 GENERAL REQUIREMENTS**

- A. The electrical and mechanical equipment shall be completely tested in the field in the presence of DEN Inspectors in accordance with good and accepted industry engineering practices to assure that:
  1. The equipment has not been damaged during manufacturing, shipping, or installation.
  2. The equipment has been installed according to the requirements Contract Documents.
  3. The equipment meets the requirements of the Contract Documents.

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- B. If the Contractor finds during the testing that any piece of equipment failed to satisfactorily pass the required field test, the DEN Project Manager shall be promptly notified and the Contractor shall take the necessary actions for the prompt repair or replacement.
- C. A retest to demonstrate the equipment will meet the requirements of the Contract Documents shall be scheduled with the DEN Project Manager.

## 2.2 GROUND RESISTANCE TEST

- A. Before connecting a ground rod to the system test the resistance to earth. Where test show resistance to ground over 5 OHMS, an additional ground rod shall be added.
- B. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI/IEEE81. Submit test results to the DEN Project Manager

## 2.3 CONDUCTOR INSULATION TEST

- A. Prior to energizing, all building service cables feeders to and/or from transformers, switchboards, panel boards are to be tested with a 1000-volt insulation megohm meter to determine insulation resistance levels. Test cables rated for three hundred volt with a 500-volt megohm meter or as recommended by the manufacturer. All field test data is to be recorded, corrected to a baseline temperature and furnished to the DEN Project Manager. A test is to include meggering between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. Airfield lighting insulation resistance testing shall conform to Item L-108. Insulation test values shall meet or exceed the values given below:

<b>Conductor Size:</b> (AWG or KCMIL)	<b>Resistance:</b> (Megaohms - 1,000 ft.)
12-8	200
6-2/0	100
3/0-750	100

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

- A. TESTING
  1. The Contractor shall allow only certified personnel to perform the testing.
  2. The Contractor shall perform the testing using all necessary safety precautions and proper test equipment.
  3. The Contractor shall notify the DEN Project Manager three (3) days in advance of the proposed testing dates.
  4. Witness of testing by DEN Inspector, Electrical Maintenance and Electrical

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Inspector.

#### **PART 4 - MEASUREMENT**

##### **4.1 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### **5.1 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this Section. Testing, Acceptances, and Certification shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 260510**

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications:
  - 1. Overhead-line grounding.
  - 2. Underground distribution grounding.
  - 3. Ground bonding common with lightning protection system.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to the metallic water pipe service on building side only and to supplementary grounding electrodes, as required by the contract documents and as required by the NEC.
- B. External (underground) metal pipes, water, gas, fuel, drain/sewer etc., are not available for electrical grounding. This is due to extensive cathodic protection and isolation joints of all underground metal pipes at DEN. These systems shall be bonded to the grounding system on the building side only.
- C. Ground each separately derived system neutral to nearest building steel or referenced ground plate in the electrical room.
- D. An insulated equipment ground conductor shall be installed continuous from the main switchgear or service entrance to all branch panelboards, motor control centers, transformers and all motors. This conductor shall be bonded to the conduit and metal enclosures that it passes through utilizing bonding bushings and terminal devices.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

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1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings:
  1. Submit shop drawings, coordination drawings, and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.
    - a. Clearly mark each shop drawing as follows for purposes of identification:
      - 1) Shop Drawing
      - 2) Equipment Identification Used on Contract Drawings
      - 3) Date
      - 4) Name of Project
      - 5) Branch of Work
      - 6) Project Manager's Name
      - 7) Contractor's Name
    - b. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.
  - C. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
  - D. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the Contract Document schedules.
- 1.5 INFORMATIONAL SUBMITTALS
  - A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
    1. Test wells.
    2. Ground rods.
    3. Grounding arrangements and connections for separately derived systems.
    4. Grounding for sensitive electronic equipment.
  - B. Qualification Data: For qualified testing agency and testing agency's field supervisor.
  - C. Field quality-control reports.
- 1.6 CLOSEOUT SUBMITTALS

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- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NFPA 70B.
  2. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
  3. Include recommended testing intervals.
- B. Record Documents
1. Maintain a contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries, and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the DEN Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the DEN Project Manager. Follow DEN BIM standards, to be furnished to the successful bidder. Record documents to be provided by the Contractor shall clearly and accurately show the following:
    - a. Provide horizontal and vertical dimensions for all raceway systems, size, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
    - b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
    - c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

## 1.8 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## PART 2 - PRODUCTS

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## 2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Codes.
- B. All ground wires shall be copper, sized according to the NEC or as shown on the drawings whichever is larger.
- C. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
  - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

## 2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connections shall be exothermic welded.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- E. Grounding Connection Accessories:
  - 1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

- B. Ground Rods in manholes ground rods shall be stainless steel ¾-inch diameter and a minimum length of 10 feet.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATIONS**

- A. Conductors: Install solid conductor for No. 12 AWG and smaller, and stranded conductors for No. 10 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 30 inches (750 mm) below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

#### **3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS**

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable

shields according to written instructions by manufacturer of splicing and termination kits.

- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
  2. Lighting circuits.
- C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
  3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- D. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

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- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Item L-115 and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one (1) test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

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**3.5 LABELING**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" Article for instruction signs.

**3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
  4. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  5. Perform tests by fall-of-potential method according to IEEE 81.
  6. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Manhole Grounds: 10 ohms.
  3. Ground resistance to earth of each ground rod: > 5 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify DEN Electrical Engineer promptly and include recommendations to reduce ground

resistance.

#### **PART 4 - MEASUREMENT**

##### 4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### 5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Grounding and Bonding for Electrical Systems shall be considered necessary and incidental to the work of this Contract.

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**TECHNICAL SPECIFICATIONS  
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SECTION 260526 – GROUNDING AND BONDING  
FOR ELECTRICAL SYSTEMS**

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## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.

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**TECHNICAL SPECIFICATIONS  
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2. Nonmetallic slotted support systems.
  3. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
1. Trapeze hangers. Include Product Data for components.
  2. Steel slotted channel systems. Include Product Data for components.
  3. Nonmetallic slotted channel systems. Include Product Data for components.
  4. Equipment supports.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Welding certificates.
- 1.7 CLOSEOUT SUBMITTALS
- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".
- 1.8 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.
- 1.9 COORDINATION
- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- 1.10 CONSTRUCTION WASTE MANAGEMENT
- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## **PART 2 - PRODUCTS**

- 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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**TECHNICAL SPECIFICATIONS  
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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
    - h. or approved equal.
  2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4. For use in dry locations only.
  5. Channel Dimensions: Selected for applicable load criteria.
- B. Hardware for hangers and supports shall be corrosion-resistant.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.

6) or approved equal.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.
7. Pneumatic-Actuated Fasteners: For use in ceilings only and by approval of DEN Project Manager. Powder-actuated tools are prohibited. Threaded-steel stud, for use in pan deck cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Hilti Inc.
    - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 3) MKT Fastening, LLC.
    - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
    - 5) or approved equal.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be **1/4 inch (6 mm)** in diameter.
- C. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2-inch (38-mm)** and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

**3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps, as appropriate and with sufficient weight rating for the application.
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements for a seismic zone 1.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
- G. Do not drill structural steel members.
- H. Install surface-mounted cabinets and panelboards with minimum of four anchors
- I. Suspended conduit or box supports shall not be less than 1/4" diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.
- J. No more than five (5) 1/2" conduits, three (3) 3/4" conduits or two (2) 1" conduits shall be supported on a single 1/4" diameter steel rod.
- K. All conduits shall be supported by approved hangers. Supports installed and used by

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other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support.

- L. Use vibration isolation pads for vibrating equipment such as transformers.
- M. Plastic or fiber anchors are prohibited.
- N. Anchoring in overhead cast in place, pre-tensioned or post-tensioned concrete is prohibited unless x-ray or ground penetrating radar study are performed and approved by the DEN Project Manager.
- O. Route conduit through roof openings provided for piping and ductwork where possible; otherwise, route through roof jack with sealant approved by the roofing manufacturer.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Install all freestanding electrical equipment on a 4" concrete housekeeping pad.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- C. Concrete materials, reinforcement, and placement requirements are specified in Item P-610.
- D. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
  
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Hangers and Supports for Electrical Systems shall be considered necessary and incidental to the work of this Contract.

END OF SECTION 260529

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## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
  - 1. Include data substantiating that materials comply with requirements.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

#### 1.6 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

### PART 2 - PRODUCTS

#### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Pre-Printed Tags: Polyester tag, 0.010 inch (**0.25 mm**) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

#### 2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Pre-Printed Tags: Polyester tag, 0.010 inch (**0.25 mm**) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

### 2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Pre-Printed Tags: Polyester tag, 0.010 inch (**0.25 mm**) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

### 2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
  1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  2. Printing on tape shall be permanent and shall not be damaged by burial operations.
  3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

**B. Color and Printing:**

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

**C. Tag: Type ID:**

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

**D. Tag: Type IID:**

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
2. Overall Thickness: 8 mils (0.2 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 300 lbf (1334 N), and 12,500 psi (86.1 MPa).

**2.5 WARNING LABELS AND SIGNS****A. Comply with NFPA 70 and 29 CFR 1910.145.****B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.****C. Baked-Enamel Warning Signs:**

1. Preprinted 20 gauge steel signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 14 by 10 inches (360 mm by 250 mm) unless 7 by 10 inches (180 by 250 mm) is the largest size that can be applied where needed.

**D. Metal-Backed, Butyrate Warning Signs:**

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with

- 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Nominal size, 14 by 10 inches (360 mm by 250 mm) unless 7 by 10 inches (180 by 250 mm) is the largest size that can be applied where needed.
- F. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
  3. "XXXX VOLTS"
  4. "KEEP AWAY"
  5. "BURIED CABLE"
  6. "DO NOT TOUCH SWITCH"
- G. Plasticized Tags:
1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, including but not limited to the following legends: "DANGER", "CAUTION", "DO NOT OPERATE".
- ## 2.6 INSTRUCTION SIGNS
- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- ## 2.7 EQUIPMENT IDENTIFICATION LABELS
- A. Adhesive Film Label: Machine printed, in black letters on white background, by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (7 mm).

- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black letters on white background, by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (7 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic, or Melamine Label: Adhesive backed, with black letters on white background. Minimum letter height shall be 1/4 inch (7 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 1/4 inch (7 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (**25 mm**).
- F. Emergency Equipment labels shall be white letters on red background.
- G. Provide nameplates with a minimum letter height as indicated below. Examples are given below for the size of letters to use for a given application and this not a list of the equipment to be identified. All equipment is required to be identified.
  - 1. For equipment designation: switchboards and motor control centers: 1/2 inch, panel boards: 1/4 inch. For voltage, bus ampacity, feeder source, and circuit number: 1/8 inch.
  - 2. Individual circuit breakers and or motor starters in motor control centers: For equipment designation and section number: 1/4 inch, for load served and location of load: 1/8 inch. Inside the door, a typed label shall provide complete motor data including nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
  - 3. Individual breakers in switchgears and switchboards: for breaker number (address number) and equipment designation; 1/4 inch, for breaker frame size and trip setting; 1/8 inch
  - 4. Individual circuit breaker and spaces in panel boards: for numbers (section number) 1/4 inch.
  - 5. Individual circuit breakers in distribution panel boards: 1/4 inch for panel being fed and 1/8 inch for its location.
  - 6. Transformers: 1/4 inch for equipment designation and size; 1/8 inch for primary and secondary voltages, primary source and circuit number, secondary load and its location.
  - 7. Individual remote indicating lights, meters, instruments, and control switches: 1/8 inch, indicate unit, equipment, or fire detector being monitored and condition indicated by illumination.
  - 8. Individual switches and pilots: 1/8 inch, identify mechanical unit being served.
  - 9. Disconnects, relay panels, lighting contactors: 1/4 inch for voltage and source circuit number.

## 2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

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1. Minimum Width: 1/8 inch (3 mm).
  2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
  2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
- 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS
- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

A. Wire and Cable Marker:

1. For wire/cables smaller than No. 2/0 use manufacturer's standard cable/conductor markers of wrap-around, pre-numbered plastic coated type are to be used and numbered to show circuit identification.
2. For cables No. 4 AWG and larger heat shrink sleeving is to be used for phase color-coding.

B. Cable/Conductor Identification:

1. The application of cable/conductor identification, with circuit number, on each wire / cable in each box/enclosure/cabinet is required. The identification shall match the marking system used in panel boards, shop drawings, and contract documents.
  - a. Provide labels on all wires, including in boxes where wires are pulled through but not terminated, such as junction boxes.

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than A, and V to ground: Identify with self-adhesive vinyl label self-adhesive vinyl tape applied in bands. Install labels at maximum intervals.

D. Junction and Pull Box ID: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Power.
2. Fiber Optics: FO.
3. Closed Circuit Television: CCTV.

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for branch-circuit conductors.
  - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
  - b. Colors for 208/120-V Circuits:
    - 1) Phase A: Black.
    - 2) Phase B: Red.
    - 3) Phase C: Blue.
    - 4) Neutral: White
    - 5) Ground: Green

- 6) Isolated Ground: Green with a yellow tracer
- c. Colors for 480/277-V Circuits:
    - 1) Phase A: Brown.
    - 2) Phase B: Orange.
    - 3) Phase C: Yellow.
    - 4) Neutral: Gray
    - 5) Ground: Green
    - 6) Isolated Ground: Green with a yellow tracer
  - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. Install instructional sign including the color-code for conductors using adhesive-film-type labels.
- G. Locations of Underground Lines: Identify with underground-line detectable warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line detectable line marker for encased duct bank, direct-buried cables, and cables in raceway.
- H. Danger Signs:
1. Critical Switches/Controls: Danger signs shall be provided on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation could result in danger to persons, or damage to equipment, or damage to or loss of property.
- I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
- J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Mechanically fastened, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high label; where

two lines of text are required, use labels 2 inches (50 mm) high. Use black lettering on white field for normal and white letters on a red field for emergency. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . . .") and emergency source circuit number when the equipment is a transfer switch or fed directly from a transfer switch.

- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label  
Stenciled legend 4 inches (100 mm) high.
  - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
  - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Panelboards: include main bus ampacity on sign. Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
  - b. Enclosures and electrical cabinets.
  - c. Access doors and panels for concealed electrical items.
  - d. Disconnect switch.
  - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
  - f. Enclosed switches.
  - g. Selector switches, indicating lights. (Circuit number and voltage not required on sign).
  - h. Enclosed circuit breakers.
  - i. Push-button stations.
  - j. Contactors.
  - k. Power-generating units.
  - l. Telephone cabinets and switching equipment. (Circuit number and voltage not required on sign.)
3. All panel boards shall have a typed panel schedule indicating the date, contractor, type of equipment served, and its location.

### 3.3 EQUIPMENT NAMING

- A. Electrical Panels shall be named according to the panel names indicated on the drawings.
- B. Naming Disconnects and Transformers
  1. Disconnects shall have the same as the equipment they serve.
  2. Transformers shall have the same name as the low-voltage panel they supply power to with the extension of -X

**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Identification for Electrical Systems shall be considered necessary and incidental to the work of this Contract.

END OF SECTION 260553

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## SECTION 260573 – ARC FLASH AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.
- C. This section also includes requirements for providing an arc flash hazard analysis and labeling all electrical equipment including switchgear, switchboards, panel boards, transformers, safety switches and other equipment likely to be examined, tested or worked on while energized.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
  - 1. Include data substantiating that materials comply with requirements.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Study and Equipment Evaluation Reports.
  - 3. Coordination-Study Report.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study and arc flash study specialist.
- B. Product Certificates:
  - 1. For coordination-study and fault-current-study computer software programs,

- certifying compliance with IEEE 399.
2. For Arc Flash software program, certifying compliance with IEEE 1584.

## 1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study and Arc Flash study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
  1. CGI CYME.
  2. EDSA Micro Corporation.
  3. ESA Inc.
  4. Operation Technology, Inc.
  5. SKM Systems Analysis, Inc.
  6. ETAP Inc.
  7. or approved equal.

### 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall

demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
  - a. Arcing faults.
  - b. Simultaneous faults.
  - c. Explicit negative sequence.
  - d. Mutual coupling in zero sequence.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
  1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

### **3.2 POWER SYSTEM DATA**

- A. Gather and tabulate the following input data to support coordination study:
  1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Impedance of utility service entrance.
  3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
    - a. Circuit-breaker and fuse-current ratings and types.
    - b. Relays and associated power and current transformer ratings and ratios.
    - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    - d. Generator kilovolt amperes, size, voltage, and source impedance.
    - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    - f. Busway ampacity and impedance.
    - g. Motor horsepower and code letter designation according to NEMA MG 1.
  4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

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- a. Special load considerations, including starting inrush currents and frequent starting and stopping.
- b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

### 3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
  1. DS East RON Panel.
  2. DS East High Mast Lighting Panel (S-19B2H1).
  3. SRE Staging Service Disconnect.
- B. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- C. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
  1. Transformers:
    - a. ANSI C57.12.10.
    - b. ANSI C57.12.22.
    - c. ANSI C57.12.40.
    - d. IEEE C57.12.00.
    - e. IEEE C57.96.
  2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
  3. Low-Voltage Fuses: IEEE C37.46.
- D. Study Report:

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1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

**E. Equipment Evaluation Report:**

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

### 3.4 COORDINATION STUDY

**A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.**

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

**B. Comply with IEEE 242 recommendations for fault currents and time intervals.**

**C. Transformer Primary Overcurrent Protective Devices:**

1. Device shall not operate in response to the following:
  - a. Inrush current when first energized.
  - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
  - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

**D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.**

- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    - a. Device tag.
    - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    - d. Fuse-current rating and type.
    - e. Ground-fault relay-pickup and time-delay settings.
  2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    - a. Device tag.
    - b. Voltage and current ratio for curves.
    - c. Three-phase and single-phase damage points for each transformer.
    - d. No damage, melting, and clearing curves for fuses.
    - e. Cable damage curves.
    - f. Transformer inrush points.
    - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

### 3.5 Arc Flash Study and labelling requirements

- A. Perform arc study using approved computer software program. Prepare labels that will be affixed to all new electrical equipment being supplied with the project. Comply with IEEE 1584.
1. Display nominal system voltage
  2. Display incident Energy
  3. Display PPE level
  4. Display working distance
  5. Display Arc Flash hazard boundary
  6. Display the equipment name, including the power source it is fed from
- B. Labels to be placed in a location that is clearly visible to qualified persons before they begin work.
- C. Arc Flash labels must be able to withstand their usage environment

## PART 4 - METHOD OF MEASUREMENT

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4.1 METHOD OF MEASUREMENT

- A. Arc-Flash and Overcurrent Protective Device Coordination Study will be paid the Contract lump sum to complete the study and accepted by the DEN Project Manager.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. Payment will be made at the Contract unit price per lump sum for Arc-Flash and Overcurrent Protective Device Coordination Study completed in accordance with the plans and specifications by the Contractor and accepted by the DEN Project Manager. This price shall include full compensation for furnishing all labor, materials, equipment, tools, and incidentals and for doing all the work of completing Arc-Flash and Overcurrent Protective Device Coordination Studies to complete this item.

Payment will be made under:

- Item 26 05 73-5.1 Arc-Flash and Overcurrent Protective Device Coordination Analysis – per lump sum

**END OF SECTION 260573**

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## SECTION 260583 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Electrical connections to equipment specified under other Sections or furnished by the Owner.
- B. Applications of electrical power, control and monitoring connections specified in this section include the following:
  - 1. To lighting fixtures and wiring devices.
  - 2. To converters, rectifiers, transformers, inverters, switchgear, switchboards, panel boards, generators, and similar equipment.
  - 3. To grounds including ground electrode connections.
  - 4. Equipment furnished in other Divisions (unless indicated otherwise).
  - 5. Electrical connections for equipment, that are not furnished as integral part of equipment, are specified in Division 27, Division 28 and other Division 26 sections and are criteria of this Section.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

#### 1.3 ACTION SUBMITTALS

#### 1.4 CLOSEOUT SUBMITTALS

- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.5 QUALITY ASSURANCE

- A. Products, materials, equipment, and systems shall comply with the following Codes and Standards:
  - 1. NFPA Compliance: NFPA 70, "National Electrical Code (NEC)" as adopted and

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amended by the Denver Building Code and as applicable to products used and the installation of electrical power connections (terminals and splices), junction boxes, motor starters and disconnect switches.

2. IEEE Compliance: Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.
3. ANSI Compliance: Applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
4. UL Compliance: UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Electrical connection products and materials are to be UL-listed and labeled.

## 1.6 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND COMPONENTS

- A. Products shall be as specified in other Sections of this Division.
- B. General: Each electrical connection shall be a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, stress cones, splice kits, termination kits, solder less wire nuts, and other items and accessories as needed to complete splices and terminations as required.
  1. Connectors and Terminals: Electrical connectors and terminals shall mate and match, including sizes and ratings, with equipment terminals that are recommended by equipment manufacturer for intended applications.
  2. Electrical Connection Accessories: Electrical insulating tape, heat-shrinkable insulating tubing and boots, stress cones, splice kits, termination kits, wirenuts, and cable ties as recommended for use by accessories manufacturers for type of services required.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

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**3.2 PREPARATION**

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

**3.3 INSTALLATION**

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations. Length shall be six feet (6') maximum.
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring as required for a complete operating system.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as required for a complete operating system. Connect with conduit and wiring as required for a complete operating system.

**3.4 EQUIPMENT CONNECTION SCHEDULE**

- A. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Division 26 of the technical specifications.

**3.5 INSTALLATION OF ELECTRICAL CONNECTIONS**

- A. Electrical connections shall be installed in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
  - 1. As a minimum: Each feeder circuit to panelboards, switchboards, motor control centers, transformers, and 480-volt (and higher) motor circuits shall have an insulated equipment ground conductor.
  - 2. Electrical service and feeders are to be maintained to occupied areas and operational facilities when temporary service is required during interruptions to existing facilities. Momentary outages for replacing existing wiring systems with new wiring systems shall be scheduled. When the "cutting-over" has been successfully accomplished, temporary wiring is to be removed.

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3. Splices shall be covered with electrical insulating material equivalent to, or of greater insulation rating, than electrical insulation rating of those conductors being spliced.
4. Cables and wires shall be trimmed as long as practicable and routing shall be arranged to facilitate inspection, testing, and maintenance.
5. Connectors and terminals, including screws and bolts, shall be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Proper torqueing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings shall be used to comply with torqueing values contained in UL 496A or the manufacturer's literature.
6. Identification markers are to be fastened to each electrical power supply wire/cable conductor in accordance with Section 260553 "Identification for Electrical Systems".
  - a. Markers are to be affixed on each terminal conductor, as close as possible to the point of connection.

### 3.6 FIELD QUALITY CONTROL

- A. The correct direction of rotation of each motor is to be verified.
- B. Provide measured torqueing value checklist with witness signature to DEN Project Manager.

## PART 4 - MEASUREMENT

### 4.1 MEASUREMENT

- A. No separate measurement will be made for the work specified in this Section.

## PART 5 - PAYMENT

### 5.1 PAYMENT

- A. No separate payment will be made for work under this Section. Electrical Connections for Equipment shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 260583**

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Photoelectric switches.
  - 2. Lighting contactors.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Interconnection diagrams showing field-installed wiring.
  - 2. Include diagrams for power, signal, and control wiring.
- C. Coordination Drawings: Include drawings to show lighting control equipment layouts and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.
- B. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.
- C. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Testing agency as defined by OSHA 29 CFR 1910.7, or a member company of the International Electrical Testing Association that is acceptable to authorities having jurisdiction.
- B. Source Limitations: Obtain lighting control equipment components through one source from a single manufacturer.
- C. Firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of lighting control equipment for not less than five (5) years.

**1.7 WARRANTY**

- A. Manufacturer shall provide a product warranty for a period of not less than two (2) years from date of installation. Warranty shall cover unlimited replacement of lighting control equipment modules during the warranty period.

**1.8 SEQUENCING AND SCHEDULING**

- A. The lighting control equipment installation is to be sequenced and scheduled with other work to reduce possibility of damage to equipment during the remainder of construction period.
- B. Power Outages: Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

**1.9 EXTRA MATERIALS**

- A. Furnish extra materials including ten (10) percent of installed units, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver materials as directed by DEN Project Manager.

**1.10 ENVIRONMENTAL CONDITIONS**

- A. The lighting control equipment unit shall be capable of continuous operation under the following temperature conditions:
1. Relative humidity: 95% non-condensing.
  2. Altitude: 5500 feet (1667 meters) without any de-rating.
  3. Functioning: -30°F (-34°C) (Outdoor) to 120°F (49°C) (Indoor & Outdoor).
  4. The neutral shall not be combined for lighting circuits with electronic or dimming ballasts, and should be bonded according to local codes and National Electrical Code (NEC).

**1.11 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 TIME SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
  2. Intermatic, Inc.
  3. Invensys Controls.
  4. Leviton Manufacturing Co., Inc.
  5. NSi Industries LLC; TORK Products.
  6. Tyco Electronics; ALR Brand.
  7. or approved equal.

**2.2 OUTDOOR PHOTOELECTRIC SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.

2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products.
4. Tyco Electronics; ALR Brand.
5. or approved equal.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 5.5 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Lightning Arrester: Air-gap type.
5. Mounting: Twist lock complying with NEMA C136.10, with base.

## 2.3 PHOTOELECTRIC CONTROL

A. Description: Completely self-contained, adjustable type, in NEMA 1 enclosure with adjustable 0 to 15 minute minimum time delay to provide a dead band zone for temporary changes in daylighting.

B. Automatic Operation:

1. Daylight Only Lighting Level 50 Footcandles or More: No fixtures on.
2. Daylight Only Lighting Level less than 50 Footcandles: Photocell No. 1 (PC 1) activates SW 1 lamps in Daylighting fixtures.
3. Daylight Only Lighting Level Less than 25 Footcandles: Photocell No. 2 (PC 2) activates SW 2 lamps in Daylighting fixtures with SW 1 lamps previously activated. All fixture lamps activated.

C. Footcandle Lighting Level Readings: Measured at the "Workplane" at 3 feet above finish floor.

- 1.

**2.4 LIGHTING CONTACTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
  2. ASCO Power Technologies, LP.
  3. Eaton Corporation.
  4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
  5. Square D.
  6. or approved equal.
- B. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

**2.5 CONDUCTORS AND CABLES**

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Item L-108.
- B. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Item L-108.

**PART 3 - EXECUTION****3.1 SENSOR INSTALLATION**

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

**3.2 CONTACTOR INSTALLATION**

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

**3.3 WIRING INSTALLATION**

- A. Wiring Method: Minimum conduit size is 3/4 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Tighten lighting control equipment assembly joints with torque wrench or similar tool recommended by bus assembly manufacturer. Tighten joints again after lighting systems have been energized for 30 days.
- F. Connect lighting control equipment assemblies and components to wiring system and to ground as indicated and instructed by manufacturer.
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- H. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.

**3.4 IDENTIFICATION**

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

**3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Manufacturer's representative shall visit site, verify installation, start up and test, and submit to DEN Project Manager, a letter stating equipment and installation meets intent of Contract Documents and manufacturer's warranties and guarantees are in effect
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

**3.6 CLEANING**

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finish to match original finish.

**3.7 PROTECTION**

- A. Provide final protection to ensure that moisture does not enter lighting control equipment assembly.

**3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.
  - 1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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TECHNICAL SPECIFICATIONS  
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SECTION 260923 – LIGHTING CONTROL DEVICES

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**PART 4 - MEASUREMENT**

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT**

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. Lighting Control Devices shall be considered as included in Exterior Lighting - Airside pay items and no additional compensation will be allowed.

**END OF SECTION 260923**

## SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
  - 1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined for Seismic Zone-1.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- B. Handle using only lift eyes and provided brackets. Protect equipment in inclement weather.

#### 1.8 COORDINATION

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- A. For floor-mounted transformers, coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. For wall-mounted and structure-mounted transformers, coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

## 1.9 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Match existing equipment in the vicinity, if applicable. Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
  - 2. General Electric Company.
  - 3. Square D; Schneider Electric.
  - 4. or approved equal.

### 2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Internal Coil Connections: Brazed or pressure type.
  - 2. Coil Material:
  - 3. Transformers rated up to 45kVA: Copper or Aluminum.
    - a. Transformers rated above 45kVA: Copper windings are required.

### 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, . NEMA 250, Type 3R.

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1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.
- E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
  2. Tested according to NEMA TP 2.
- I. Wall Brackets: Manufacturer's standard brackets.
- J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91. Maximum sound levels shall be as follows:
1. 1 to 5 kVA: 37dB.
  2. 6 to 25 kVA: 42dB.
  3. 26 to 150 kVA: 47dB.

**2.4 IDENTIFICATION DEVICES**

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
1. Include transformer connection data and overload capacity based on rated allowable temperature rise.

**2.5 SOURCE QUALITY CONTROL**

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

**3.3 CONNECTIONS**

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Item L-108.

**3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including

connections, and to assist in testing.

- B. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  2. Perform two (2) follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
  3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### 3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

### 3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

## PART 4 - MEASUREMENT

### 4.1 METHOD OF MEASUREMENT

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- A. No separate measurement shall be made for work under this Section.

## **PART 5 - PAYMENT**

### 5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. Low Voltage Transformers shall be considered necessary and incidental to the work of this Contract.

END OF SECTION 262200

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**SECTION 262416 - PANELBOARDS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Distribution panelboards.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

**1.3 DEFINITIONS**

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
  - 1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations

- of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  3. Detail bus configuration, current, and voltage ratings.
  4. Short-circuit current rating of panelboards and overcurrent protective devices.
  5. Include evidence of NRTL listing for series rating of installed devices.
  6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  7. Include wiring diagrams for power, signal, and control wiring.
  8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field Quality-Control Reports:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Panelboard Schedules: For installation in panelboards.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: Two (2) spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types.

3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

### 1.9 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

### 1.11 PROJECT CONDITIONS

- A. Environmental Limitations:
  1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding minus 30 deg F (minus 35 deg C) to plus 120 deg F (plus 49 deg C).
    - b. Altitude: **5500 feet** (1677 m), not exceeding **6600 feet** (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  1. Ambient temperatures within limits specified.
  2. Altitude: 5500 feet, not exceeding **6600 feet** (2000 m).

- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
  2. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
  3. Comply with NFPA 70E.

#### 1.12 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.13 WARRANTY

- A. Special Warranty: for Surge Suppression Devices Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Minimum five (5) years from date of Substantial Completion.

#### 1.14 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section "Vibration and Seismic Controls for Electrical Systems."

- B. Enclosures: Surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
  2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  6. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Same finish as panels and trim.
  7. Enclosures shall be at least 20 inches wide made from galvanized sheet steel in the sizes and NEMA types indicated, code gauge, minimum 16 gauge thickness
  8. Directory Card: Inside panelboard door, mounted in transparent card holder .
- C. In all cases where the conductor to be connected to the busbar is 1/0 or larger cable, the connection shall be made with a 2-hole compression lug. Torque all lug, wire and bus terminations to the manufacturers recommendation using a micrometer type wrench.
- D. Incoming Mains Location: Bottom.
- E. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  4. Split Bus: Vertical buses divided into individual vertical sections.
- F. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Main and Neutral Lugs: Mechanical type.
  3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

- I. Breakers shall have built-in test points for testing long delay, and instantaneous functions of the breaker by means of a 120 volt operated test kit.
  
- J. General Requirements for Branch Circuit Panelboards:
  - 1. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers, of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
  - 2. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and up through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as Type SWD for lighting circuits.
    - a. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.
    - b. Main circuit breaker, when shown, shall be vertical mounted top or bottom as required. Chassis mounted reverse fed main circuit breaker is not acceptable.
  - 3. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts and 14,000 amperes symmetrical at 480 volts.

## 2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Match existing manufacturer in the immediate area, if applicable. Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Square D; a brand of Schneider Electric.
  - 4. or approved equal.
  
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
  
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
  
- D. Mains: Circuit breaker.
  
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
  
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Square D; a brand of Schneider Electric.
  4. or approved equal.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully-rated interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 600 A and below.
  2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
    - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
  2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

## 2.4 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology; a subsidiary of Danahar Corporation.
  2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  4. Liebert Corporation.
  5. Square D; a brand of Schneider Electric.
  6. or approved equal.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
    - a. LED indicator lights for power and protection status.
    - b. Audible alarm, with silencing switch, to indicate when protection has failed.
    - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
    - a. LED indicator lights for power and protection status.
    - b. Audible alarm, with silencing switch, to indicate when protection has failed.
    - c. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    - d. Four-digit, transient-event counter set to totalize transient surges.
  2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
  3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
    - a. Line to Neutral: 70,000 A.
    - b. Line to Ground: 70,000 A.
    - c. Neutral to Ground: 50,000 A.
  4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 -V, three-phase, four-wire circuits shall be as follows:
    - a. Line to Neutral: 800 V for 480Y/277.
    - b. Line to Ground: 800 V for 480Y/277.

- c. Neutral to Ground: 800 V for 480Y/277.
- 5. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:
  - a. Line to Neutral: 400 V.
  - b. Line to Ground: 400 V.
  - c. Neutral to Ground: 400 V.
- 6. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
  - a. Line to Neutral: 400 V, 800 V from high leg.
  - b. Line to Ground: 400 V.
  - c. Neutral to Ground: 400 V.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Comply with mounting and anchoring requirements specified in Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim **78 inches (1982 mm)** above finished grade unless matching height of existing equipment or approved otherwise.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

- E. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub five 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub five 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Comply with NECA 1.

### 3.3 PANELBOARD SCHEDULE

- A. Panelboards shall be furnished and equipped as follows, except as otherwise specified:

Manufacturer:	120/208V:	277/480V:
Cutler Hammer	PRL-1	PRL-2
Square-D	NQOD	NEHB
GE	NLAB	NHB

Or approved equal by other manufacturer.

- B. Distribution panelboard shall be scheduled where more than one subfeed breaker rated in excess of 100A is required, and for any panelboard containing breakers with ratings of 225A or more.

### 3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Clearly identify the load on each circuit, equipment serviced and location. Revise directory to reflect circuiting changes required to balance phase loads. In all instances where a contractor installs or disconnects a circuit in any panel, a newly typed panel schedule shall be furnished. The new or revised panel schedule shall have the date and Contractor's name typed at the top right hand corner. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with

a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections, preparing a written report for each including test results:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard eleven (11) months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Submit torque values for all connections with a torque schedule and witness signature.

**3.6 ADJUSTING**

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

**3.7 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

**PART 4 - MEASUREMENT****4.1 METHOD OF MEASUREMENT**

- A. Panelboards and receptacle arrays will be paid the Contract lump sum for each type installed, complete, and in-place, ready for operation, and accepted by the DEN Project Manager.

**PART 5 - PAYMENT****5.1 PAYMENT**

- A. Payment will be made at the Contract unit price per lump sum for each item completed in accordance with the plans and specifications installed by the Contractor and accepted by the DEN Project Manager. This price shall include full compensation for furnishing all labor, materials, equipment, tools, assembly and installation of these materials, and incidentals necessary to complete this item.

Payment will be made under

Item 26 24 16-5.1 Install DS East MDP Panel – per lump sum

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Install MDP panel, 480Y/277V, 3P, 4W, NEMA-3R including, fused service disconnect switch, CT cabinet, meter socket, coordination with Xcel Energy, circuit breakers, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, conduit between service and Xcel Energy transformer, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.2 Install DS East Lighting Panel – per lump sum

Install DS East Lighting panel, 480Y/277V, 3P, 4W, NEMA-3R including, circuit breakers, lighting control enclosure (complete), manual 3-position switch for light level control, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.3 Install SRE Crew Panel – per lump sum

Install SRE Crew panel, 208Y/120V, 3P, 4W, NEMA-3R including, pad-mounted transformer, fusible safety switches, fuses, circuit breakers, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, liquid tight flex conduit, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.4 Install SRE Receptacle Panel – per lump sum

Install SRE Crew panel, 208Y/120V, 3P, 4W, NEMA-3R including, pad-mounted transformer, fusible safety switches, fuses, circuit breakers, PVC coated RGS conduit, PVC conduit within 5 feet of the rack foundation, RGS conduit, liquid tight flex conduit, excavation, concrete, welded wire mesh, strut, grounding electrode system, ground rods, floor flanges, bolts, and all necessary incidentals to complete this item.

Item 26 24 16-5.5 Install SRE Receptacle Rack Arrays – per lump sum

Install SRE receptacle rack arrays including, double block and double rail barrier, steel posts, NEMA 4X enclosures, PVC coated RGS conduit, RGS conduit, liquid tight flex conduit, branch circuit cables from SRE Receptacle Panel, NEMA 3R power outlet control panels, red pilot lights, power cable and receptacle factory assembled cord sets, water tight strain relief connector, steel channel, pipe clamps, and all necessary incidentals to complete this item.

**END OF SECTION 262416**

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**SECTION 262813 - FUSES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in control circuits and enclosed switches.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
  - 5. Coordination charts and tables and related data.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
  2. Current-limitation curves for fuses with current-limiting characteristics.
  3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
  4. Coordination charts and tables and related data.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.

**1.6 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

**1.7 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

**1.8 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**1.9 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann.
  2. Edison; a brand of Cooper Bussmann.
  3. Ferraz Shawmut, Inc.
  4. Littelfuse, Inc.
  5. General Electric.
  6. Gould.
  7. Reliance.
  8. or approved equal.

**2.2 CARTRIDGE FUSES**

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 FUSE APPLICATIONS****A. Cartridge Fuses:**

1. Service Entrance: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class J, fast acting Class J, time delay Class T, fast acting.
2. Feeders: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class RK5, fast acting Class RK5, time delay Class J, fast acting.
3. Control Circuits: Class CC, fast acting time delay.

**3.3 INSTALLATION**

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

**3.4 IDENTIFICATION**

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

**PART 4 - MEASUREMENT****4.1 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.1 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this Section. Fuses shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 262813**

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Molded-case circuit breakers (MCCBs).
  - 3. Enclosures.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

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1. Enclosure types and details for types other than NEMA 250, Type 1.
  2. Current and voltage ratings.
  3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  4. Include evidence of NRTL listing for series rating of installed devices.
  5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
  7. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.
1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Manufacturer's field service report.
- 1.7 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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**1.8 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.
  - 2. Fuse Pullers: Two (2) for each size and type.

**1.9 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

**1.10 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 30 deg F (minus 35 deg C) and not exceeding 120 deg F (49 deg C).
  - 2. Altitude: 5500 feet (1677 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
  - 2. Indicate method of providing temporary electric service.

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3. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
4. Comply with NFPA 70E.

**1.11 COORDINATION**

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**1.12 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 FUSIBLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. or approved equal.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

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4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

**2.2 MOLDED-CASE CIRCUIT BREAKERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. or approved equal.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
  2. Long- and short-time pickup levels.
  3. Long- and short-time time adjustments.
  4. Ground-fault pickup level, time delay, and  $I^2t$  response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

**2.3 ENCLOSURES**

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Outdoor Locations: NEMA 250, Type 3R.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

**3.3 IDENTIFICATION**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

**3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.5 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
  - B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

**PART 4 - MEASUREMENT****4.1 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

**PART 5 - PAYMENT****5.1 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this Section. Enclosed Switches and Circuit Breakers shall be considered necessary and incidental to the work of this Contract.

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**END OF SECTION 262816**

## SECTION 265650 - EXTERIOR LIGHTING - AIRSIDE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. This Section defines performance and design standards for area lighting located on the airside, primarily at aircraft parking, servicing, and holding positions.

B. The lighting fixture selections and layouts shown on the drawings are to be used in conjunction with the requirements contained in this Section. Contractor shall engage the services of a qualified lighting design firm or manufacturer to provide a fully engineered lighting design.

C. All lighting components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers, and enclosures shall be factory assembled, aimed, wired, and tested.

D. Contractor shall furnish and install all lighting equipment and lighting fixtures including poles, luminaires, drivers, control equipment, etc., as required for all areas in accordance with the accepted lighting design and shop drawings.

E. The contractor's lighting installation shall meet the following primary goals:

1. Spill and glare control: The primary objective of airside lighting installations is to provide the specified lighting while minimizing spill light, up-light, direct glare, and indirect (reflected) glare.
2. Guaranteed light levels: Provide light sources that are configured to maintain consistent target light levels as specified herein for a minimum period of 10 years from substantial completion.
3. Total cost of ownership: Provide energy-efficient, long-lasting light sources. Any required repairs or maintenance to maintain specified light levels over the 10-year warranty performance period shall be included in the project.

F. Airside lighting shall comply with FAA AC 150/5360-13A, IES RP-37-15, and all requirements contained in this Section.

G. Section Includes:

1. Exterior airside LED luminaires with remote drivers.
2. Poles and accessories.
3. Control devices.

H. Related Sections:

I. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

### 1.3 DEFINITIONS

A. ADG: Aircraft Design Group. Aircraft sizing criteria defined by the FAA. Ranges from ADG I (smallest) to ADG VI (largest).

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. Ground Load Gate: An aircraft loading gate without an enclosed passenger loading bridge. Ground load gates may or may not be located adjacent to a building.

E. HID: High-intensity discharge.

F. LER: Luminaire efficacy rating.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

H. Mainline Gate: An aircraft loading gate equipped with an enclosed passenger loading bridge and associated service facilities. Mainline gates are typically designed to service aircraft in ADG III and above, but occasionally may service smaller aircraft.

I. Pole: Luminaire support structure, including tower used for large area illumination.

J. Remain Overnight (RON) Pad: An aircraft parking position that is not used or intended for passenger loading.

K. Standard: Same definition as "Pole" above.

L. Taxilane: The section of aircraft taxiing route located closest to each concourse, utilized for aircraft push-back. Commonly identified with a purple centerline marking.

M. Taxiway: Aircraft taxiing routes, other than taxilanes as defined above.

N. VSR: Vehicle Service Road. Ground-based vehicle roads located on the airfield.

### 1.4 LIGHTING PERFORMANCE REQUIREMENTS

A. Illumination levels: Lighting shall meet the illumination targets as specified below. Contractor shall provide a comprehensive lighting design submittal and field measurements in accordance with this Section to document compliance with requirements. The deice parking positions and the SRE/GSE staging pad shall meet the following horizontal illumination (footcandle) requirements using a 10-foot by 10-foot grid.

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Area	Average	Min	Max
Deice Pad	2.0	0.45	6.0
SRE/GSE Staging	0.95	0.15	2.0

- B. Hours of usage: Airside area lighting shall be provided with daylight-responsive controls to operate from dusk to dawn daily. Annual and 10-year usage shall be assumed to be as follows:

Area	Annual Usage, hours	10-year usage, hours
Remain Overnight (RON) Positions	5,000	50,000

- C. Spill and Glare Control:

- All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shield, louvers, and external shields. Symmetrical flood beam patterns are prohibited.
- Glare control: Candela values contributed by the project shall not exceed the following:

Area	Maximum
Taxiway CN centerline	5,000 Cd
Concourse A & B ramp tower cabs	0 Cd
FAA Control tower cab	0 Cd

- D. Spill scans: Photometric measurements shall include horizontal and vertical spill scans at the horizontal and vertical boundary lines as specified in the lighting performance requirements above.

- E. Dusk-to-dawn lighting control:

- Lighting system shall be equipped with daylight-responsive controls to enable activation of lighting system at dusk, and deactivation of system at dawn.
- Utilize photoelectric sensors connected to a networked lighting control system to provide dusk-to-dawn control.
- Lighting control system shall be integrated with the DEN EMCS using standard BACNet communication protocols.
- Provide 3-position switch adjacent to lighting control enclosure to manually set light output at 33%, 50%, and 100% of rated light output.

## 1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.

- C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
1. Basic wind speed for calculating wind load for poles exceeding 50 feet (15 m) in height is 115 mph.
    - a. Wind Importance Factor: 1.3
    - b. Minimum Design Life: 50 years.
    - c. Velocity Conversion Factors: 1.3

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  2. Details of attaching luminaires and accessories.
  3. Details of installation and construction.
  4. Luminaire materials.
  5. Wind loading data.
  6. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, remote driver, and accessories.
    - a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  7. Photoelectric relays.
  8. Drivers, including energy-efficiency data.
  9. Solid-State Lamps, including rated life, output, CCT, CRI, lumens, and energy-efficiency data.
  10. Materials, dimensions, and finishes of poles.
  11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  12. Anchor bolts for poles.
  13. Manufactured pole foundations.
  14. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Lighting design drawings, including:
    - a. Area name, date, file number.
    - b. Site plan of project areas, indicating pole locations, surrounding buildings, and horizontal illuminance levels at specified grid spacing and calculation plane height.

- c. Photometric statistics, including average, minimum, and maximum foot-candles in the lit area; uniformity (max/min); horizontal and vertical illuminance at area boundaries.
  - d. Spill scans, showing maximum candela at specified glare control locations and starting at the edge of the lit area continuing until 500 candela or less is achieved.
  - e. Overall statistics, including power consumption (initial and 10-year); average tilt factor; light loss factor.
  - f. Overall pole height(s), number of fixtures per pole, horizontal and vertical aiming angles.
  - g. Luminaire wattage, lumen output, and optical configuration.
2. Engineered structural design for poles, for pole foundations, signed and sealed by a professional structural engineer licensed in the state of Colorado.
  3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  4. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  5. Wiring Diagrams: For power, signal, and control wiring.
- C. EMCS Graphics Pages: For lighting controls integration.
- D. Substitutions: For Pre-bid approval, submit all materials noted in paragraphs A and B above.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- B. Qualification Data:
1. For qualified agencies providing photometric data for lighting fixtures.
  2. For lighting designer: Submit (3) example projects in which the lighting designer served as the principal in charge of the lighting design.
  3. For structural engineer: Licensing information.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1. Include contact information for the manufacturer's local service representative, to be contacted in the event of a manufacturer warranty issue.
- B. Connectors and terminals, including screws and bolts, are to be tightened in accordance with equipment manufacturer's published torque tightening values. Record all torque values for bolts and submit report with witness signature to DEN Project Manager.
- C. Contractor shall provide to the DEN Project Manager a Point by Point report showing the light level readings taken after the luminaires have been properly aimed and have had at least 50 hours of actual run time in the field. The grid spacing for the readings shall be the same as the calculations submitted prior to start of construction.
  1. For luminaires with step-dimming control, provide an additional point-by-point report showing light level readings
- D. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials as directed by DEN Project Manager.
  1. Luminaires: Five (5) percent of the total number of luminaires, but not less than two (2) luminaires, for each type and rating installed.
  2. Drivers: One (1) for every 50 of each type and rating installed. Furnish at least one of each type.
  3. Fuses: One (1) for every 50 of each type and rating installed. Furnish at least two of each type.

#### 1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the latest edition of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and

application.

- E. Comply with IEEE C2, "National Electrical Safety Code."
- F. Comply with NFPA 70.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to:
  - 1. Repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period.
  - 2. Guarantee overall light levels as specified in this Section, with a total lumen depreciation factor of 0.95 over the warranty period to account for dirt depreciation and other environmental factors.
  - 3. Manufacturer agrees to repair or replace luminaires in the event that light levels are found to be out of compliance with the specified levels.
  - 4. Manufacturer agrees to provide a factory-authorized service representative onsite at the time of any warranty repairs to coordinate with DEN operations and maintenance staff and provide any required labor necessary to perform necessary warranty repair work.
- B. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
- C. Lighting supplier shall warrant the complete installation, including poles, hardware and accessories. In cases where the lighting supplier is not a manufacturer of poles, lighting supplier shall fully warrant the poles and any other 3<sup>rd</sup>-party hardware as a first-party product, in order to provide a single point of contact and service for all warranty-related issues for the entirety of the warranty period.
- D. Warranty Period: Minimum ten (10) years from date of Substantial Completion.

#### 1.10 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, provide products for luminaires, poles and accessories from one of the following:
1. Musco Lighting, LLC.
  2. Acuity Lighting.
  3. Eaton/Cooper Lighting.

**2.2 GENERAL REQUIREMENTS FOR LUMINAIRES**

- A. Environmental Conditions:
1. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:
    - a. Location: Outdoors.
    - b. Altitude: 5,500 feet (1677 m) above sea level.
    - c. Ambient Temperature Range: Minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C).
    - d. Wind Load: 115 mph with gust factor of 1.3.
- B. Provide lighting equipment as shown on the drawings and as specified herein. Provide complete lighting equipment, including canopies, poles, supporting brackets, hickies, casing, socket holders, reflectors, drivers, solid-state lamps, etc., as appropriate for the application. Provide special plates, barriers, rings, etc., as required to comply with National Electrical Code. The fixtures to have proper gasketing and made of corrosion resistant materials to be installed in damp and wet locations.
- C. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

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- H. Exposed Hardware Material: Stainless steel.
- I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- J. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- K. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
  2. Specular Surfaces: 83 percent.
  3. Diffusing Specular Surfaces: 75 percent.
- L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- M. Constant Lumen Output: Overall lumen output of luminaires shall not degrade by more than 5% over the 10-year warranty period. Products provided shall employ constant lumen output drivers, designed to compensate for lumen depreciation over the life of the lamps.
1. Projected non-compensated lumen maintenance shall be at least 70% of original output at 100,000 hours, as measured in accordance with IES TM-21.
- N. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  2. Exterior Surfaces: Manufacturer's hot-dip galvanized finish.
    - a. Color: Grey.
- P. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I,

clear coating 0.018 mm or thicker) complying with AAMA 611.

- Q. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:
  - a. "USES ONLY" and include specific lamp type.
  - b. CCT and CRI for all luminaires.

## 2.3 OUTDOOR PHOTOELECTRIC SENSORS

- A. Comply with Section 260923 "Lighting Control Devices" for outdoor photoelectric sensors.

## 2.4 DRIVERS FOR SOLID-STATE LAMPS

- A. Description: Listed, electronic, RoHS compliant, meeting the requirements of ANSI C82.77 and UL 8750.

1. Remote drivers shall be provided, integral driver luminaires will not be accepted.
2. Dimming: Where required. Meet or exceed specified dimming percentage. Provide 4-wire (0-10V DC Voltage Controlled) dimming drivers which meet the following requirements:
  - a. Compatible with solid-state devices within the range of 10%-100% of the power supply output.
  - b. Meet IEC 60929 Annex E for General White Lighting LED drivers.
  - c. Connect to devices compatible with class 2 0-10V analog control protocol.
  - d. 0-10V control interface shall be completely isolated from the line-voltage AC power supply.
  - e. Available sink current for each driver on the 0-10V interface shall not exceed 1 mA.
3. Temperature rating: Match or exceed environmental requirements.
4. Rated Life: 100,000 hours minimum.
5. Manufacturer's Warranty: Five (5) years minimum.
6. Input voltage range: 120-480 VAC, +/- 10%.
7. Power factor: 0.9, minimum.
8. THD: 10% maximum at full load.
9. Efficiency: 85% minimum at full load.
10. Provide surge protection for drivers at each light pole. Surge protection rating shall be 40kA minimum for each line-to-ground (common mode) as recommended by IEEE C62.41.2.

**2.5 SOLID-STATE LAMPS**

- A. LED lamps: ANSI C78.377, listed and rated for the intended environmental conditions.
- B. Color Rendering:
  - 1. Minimum CRI: 70.
- C. Correlated color temperature (CCT): 4000K.
- D. Minimum LED life: 50,000 hours at a depreciation-compensated lumen output no less than 95% of original output, including environmental factors. 100,000 hours minimum to a non-compensated output of 70%. Lumen maintenance measurements and calculations must conform to IES LM-80 and IES TM-21.
- E. Lumen output shall be as specified in the shop drawing submittal. Conform to IESNA LM-79.

**2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS**

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
  - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
  - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.3 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor bolts shall meet or exceed wind loading and structural requirements.
  - 3. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  - 4. Anchor-Bolt Template: Plywood or steel.
  - 5. Ground bolt near the handhole shall be included.
- D. Handhole: Oval-shaped, reinforced, with minimum clear opening of 3 inches by 5 inches (76 by 130 mm) minimum, with cover secured by stainless-steel captive screws. Provide larger size handholes to suit pole diameter.
- E. Concrete Pole Foundations: Precast with concrete backfill or cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Item P-610.

**F. Lightning protection:**

1. Manufacturer shall provide integrated lightning grounding via concrete encased electrode grounding system as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode Comply with Section 260526 "Grounding and Bonding for Electrical Systems," with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2/0 AWG for poles with more than 75 feet mounting height.

**2.7 STEEL POLES**

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction with access handhole in pole wall.
  1. Shape: Round, tapered.
  2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with hot-dip galvanized steel bolts.
  2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- G. Hot-Dip Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent

Cleaning," to remove dirt, oil, grease, and other contaminants that could impair bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: Factory hot-dip galvanized finish.
3. Exterior Surfaces: Factory hot-dip galvanized finish.

a. Color: Grey.

## 2.8 POLE ACCESSORIES

- A. Driver enclosure: NEMA 3R, lockable, hinged steel enclosure, sized to accommodate all remote drivers, fuses, and accessories required. Painted to match pole finish.
  1. Mounting: secured to pole with stainless steel fasteners.
  2. Provide opening from rear of driver enclosure into pole interior, sized as required, to conceal all wiring from power supply to drivers and from drivers to luminaires.
  3. Mounting height: 10 feet above finished grade to bottom of enclosure.
  4. Drivers, fuses and other devices shall be securely mounted to enclosure using DIN rail or steel backplane.
  5. Enclosure shall be capable of being opened during operation without interrupting power to luminaires.
- B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

## PART 3 - EXECUTION

### 3.1 INSTALLATION GENERAL

- A. Sequence and Schedule: The exterior lighting installation is to be sequenced and scheduled with other work to reduce possibility of damage and soiling of fixtures during the remainder of construction period.
- B. Power Outages: Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
- C. Photocells and Timers: The fixtures shall operate on the voltage shown. Provide and install all photocells and/or timer devices for automatic operation of the fixtures as described in the construction documents. Refer to lighting control specification sections for additional requirements.
- D. Torque Values: Connectors and terminals, including screws and bolts, are to be tightened in accordance with equipment manufacturer's published torque tightening values. Record all torque values for bolts and submit report with witness signature to DEN Project Manager.

**3.2 LUMINAIRE INSTALLATION**

- A. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- B. Engage the services of a factory-authorized representative to adjust luminaires that require field adjustment or aiming.

**3.3 POLE INSTALLATION**

- A. The pole will be installed according to the manufacturer's recommendations.
- B. Pole layout: As shown on drawings.
  - 1. Poles shall not be located within 25 feet of the edge of any aircraft safety envelope.
  - 2. Pole locations shall be selected to minimize interference with ground service equipment operation and maneuvering.
  - 3. Final pole layouts must be approved by airside operations and airport planning.
- C. Grounding will comply with National Electrical Code requirements.
- D. Provide individual fuses at each pole for each driver, installed in the remote driver enclosure.
- E. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- F. Clearances: Maintain the following minimum clear horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (**1520 mm**).
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (**3 m**).
- G. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Item P-610.
- H. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers unless otherwise indicated.
  - 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

- I. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
  - 1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
  - 2. Fill augered hole around pole with concrete per Item P-610, and finish in a dome above finished grade.
  - 3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
  - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- J. Raise and set poles using web fabric slings (not chain or cable).

### 3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Item L-110. In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Luminaires shall be factory-aimed to conform with the accepted lighting design shop drawings. If factory aiming is not possible, provide a manufacturer's service representative onsite to observe and direct fixture aiming during installation.
- C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - 1. Verify operation of photoelectric controls.
- D. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

a. IESNA RP-37-15, "Outdoor Lighting for Airport Environments," annex B.

- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- F. Cleaning: Clean all fixtures of dirt and debris upon completion of the installation and protect fixtures from damage during construction period.

### 3.7 DEMONSTRATION

- A. Demonstrate capability and compliance with specified requirements upon completion of installation of exterior lighting fixtures and associated circuiting.
- B. All lighting fixtures having an adjustable type beam spread or pole mounted apron ramp area being of the adjustable aiming type shall be field adjusted or aimed at the Contractor's expense and to the satisfaction of the DEN Project Manager.
- C. All fixtures shall be field adjusted (verify final placement of fixtures also) in accordance with the manufacturer's aiming recommendations, and as indicated on the drawings and as required in the field. Include an allowance in the bid to cover all costs of aiming or adjusting these fixtures. Include an overtime allowance in the bid for aiming or adjusting exterior fixtures at night.
- D. Operational Readiness Test:
  - 1. Following completion of installation, aiming and startup, contractor shall demonstrate operation of all luminaires.
  - 2. Demonstration shall be performed at night, in the presence of the following attendees or their designee:
    - a. DEN Project Manager.
    - b. DEN Technical Maintenance.
    - c. DEN Ramp Tower manager.
    - d. FAA Tower representative.
  - 3. Demonstration shall include the following:
    - a. Operation of on/off lighting controls.
    - b. Fixture aiming verification.
    - c. Field observation of general illumination levels in the project area.
    - d. Glare evaluation at the project boundaries.
- E. Submit photometric report of light levels in all exterior areas to DEN Project Manager. All photometric readings shall be taken after a minimum of forty (40) hours burn-in of light fixtures.
- F. Contractor shall provide to the DEN Project Manager a Point by Point report showing the light level readings taken after luminaires have been properly aimed and the fixtures have had at least 50 hours of actual run time in the field. The grid spacing for

the readings shall be the same as the calculations submitted prior to start of construction.

- G. Training: Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice. Engage a factory-authorized service representative to assist Contractor and train DEN maintenance personnel to adjust, operate, and maintain all exterior lighting components, and luminaire lowering devices, if any.
1. Comply with Section 017515 “System Startup, testing and training” and Section 017900 “Demonstration and Training.”

## PART 4 - MEASUREMENT

### 4.1 METHOD OF MEASUREMENT

- A. High mast lights will be paid the Contract per type installed, complete and in-place, ready for operation, and accepted by the DEN Project Manager.

## PART 5 - PAYMENT

### 5.1 PAYMENT

- A. Payment shall be made at the Contract unit price per each for each item completed in accordance with the plans and specifications that is installed by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 26 56 50-5.1 Install High Mast Lighting on New Foundation – per each

Install High Mast Lighting shall include, foundation design, excavation, rebar, concrete, grounding, foundation, round tapered steel pole, remote driver enclosure, strut, fuses, conductors in pole, luminaires, conduit from enclosure to pole, provide a means to route comm cable from an above grade enclosure through the pole to interface with cameras, luminaire aiming, and all necessary incidentals to complete this item.

**END OF SECTION 265600**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 265650 – EXTERIOR LIGHTING - AIRSIDE**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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## **SECTION 271300 - COMMUNICATIONS BACKBONE CABLING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:

1. Pathways.
2. UTP cable.
3. Single Mode Fiber Optic Cable 9/125 micrometer.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Cabling identification products.

- B. Related Sections:

1. Section 260553 "Identification for Electrical Systems" for identification of cable systems and components.
2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### **1.3 DEFINITIONS**

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.
- G. UTP: Unshielded twisted pair.

#### 1.4 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- C. All work designed and constructed under this section shall comply with EIA/TIA 568, 569, 606 and relevant Building Industry Construction Service, Inc. (BICSI Standards).
- D. Designers are required to submit a complete set of plans and specifications for their projects to the DEN Telecommunications Department for review and approval. Designers are also required to meet with representatives from the DEN Telecommunications Department at one or more times during the course of design to work out specific interface details prior to the final submittal.
- E. Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete system of telecommunications pathways, spaces and cabling as required by the specifications and as shown on the Drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of work not mentioned or shown which are necessary for the successful operation of all telecommunications systems.
- F. Backbone copper and fiber cabling at DEN are assigned unique numbers that allow cabling pair and strand assignments to be managed by the DEN cable management system. Backbone (BB) and Inter-Building (IB) cable number assignments shall be coordinated with the DEN Technologies to ensure that numerical assignments do not conflict with existing cable designations used elsewhere in the airport.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: Provide complete product data for each element of cabling, and equipment proposed. Where a data sheet covers multiple items specifically mark items proposed for use on the Project.
  - 1. Include data substantiating that materials comply with requirements.

**B. Shop Drawings:**

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:
  - a. Cross-connects.
  - b. Patch panels.
  - c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

**1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Contractor, installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Maintenance Data: For splices and connectors to include in maintenance manuals.

**1.8 CLOSEOUT SUBMITTALS**

- A. Software and Firmware Operational Documentation:
  1. Complete test records for all cable tests.
  2. Diagrams indicating route, cable types, pair or strand count and cable ID numbers used in the Project.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".
  1. Provide complete as-built drawings for all IDF rooms, backbone conduit routes and tray routes indicating actual routing.

**1.9 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Patch-Panel Units: One (1) of each type.

2. Connecting Blocks: One (1) of each type.

#### 1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
  3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: An NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- F. Grounding: Comply with ANSI-J-STD-607-A.

#### 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
  2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
  3. Test each pair of UTP cable for open and short circuits.

**1.12 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Verify that field measurements are as shown on Drawings.
- C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required by field verification.

**1.13 COORDINATION**

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers, and with DEN Project Manager.
- B. **CONSTRUCTION WASTE MANAGEMENT**
  - 1. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. All metal conductors shall be copper.
- B. All building wire and cable shall be installed in approved raceways.
- C. Materials and Equipment: Acceptable to the authority having jurisdiction and suitable for the use intended, except where more stringent requirements are indicated as described herein.

**2.2 PATHWAYS**

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Reference Item L-110 for wire pathways, wireways, conduit and fittings.
- C. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
  - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
  - 2. Lacing bars, spools, J-hooks, and D-rings.

3. Straps and other devices.

D. Conduit and Boxes: Comply with requirements in Item L-110. Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

### 2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
13. or approved equal.

B. Description: 100-ohm, 24AWG, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Elevator cabling shall be gell filled with an overall polyethylene sheath.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
  - a. Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG.

### 2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.

5. Leviton Voice & Data Division.
  6. Molex Premise Networks; a division of Molex, Inc.
  7. Nordex/CDT; a subsidiary of Cable Design Technologies.
  8. Panduit Corp.
  9. Siemon Co. (The).
  10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
  11. or approved equal.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 5E or Category 6 . Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, 4-pair cables in 36-inch (**900-mm**) lengths; terminated with 8-position modular plug at each end. Termination sequence shall be EIA/TIA 568B.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
  2. Patch cords shall have color-coded boots for circuit identification.
- 2.5 OPTICAL FIBER CABLE
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek; a Nexans company.
  2. CommScope, Inc.
  3. Corning Cable Systems.
  4. General Cable Technologies Corporation.
  5. Mohawk; a division of Belden CDT.
  6. Nordex/CDT; a subsidiary of Cable Design Technologies.

7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
12. or approved equal.

B. Description: Single-mode, 125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ITU G.652.D.
2. Comply with ICEA S-87-640 for mechanical properties.
3. Comply with TIA/EIA-568-B.3 for performance specifications.
4. Comply with TIA/EIA-492AAAA-B for detailed specifications.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
  - a. General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP.
6. Conductive cable shall be steel armored type.
7. Maximum Attenuation: 1.8 dB/km at 850 nm.
8. Single Mode fiber shall be type SMF28E.
9. Minimum Modal Bandwidth: 160 MHz-km at 850 nm.

C. Jacket:

1. Jacket Color: Yellow for Single Mode Fiber.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

## 2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).
11. Superior Modular Products.
12. or approved equal.

- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered cable connectors. Connector type for all strands except those used for analog services shall be type LC. Strands used for analog services such as DEN TV and Distributed Antenna Systems shall be terminated with APC high return loss terminations.
  - 1. Number of Connectors per Field: One (1) for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords: Factory-made, single or dual-fiber cables in 36-inch (900-mm) incremental lengths.
- D. Cable Connecting Hardware:
  - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
  - 2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
  - 3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

## 2.7 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

## 2.8 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Reference Section 260553 "Identification for Electrical Systems" for identification of cable systems and components.

## 2.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**PART 3 - EXECUTION****3.1 GENERAL**

- A. All Work to be coordinated with and approved by DEN Telecommunications Department and DEN Project Manager.
- B. All Work to be coordinated with existing systems at DEN.

**3.2 WIRING METHODS**

- A. Verify pathways are open, continuous and clear of debris before installing cables.
- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

**3.3 INSTALLATION OF PATHWAYS**

- A. Drawings indicate general arrangement of pathways and fittings.
- B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Item L-110 for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- E. Install wire in raceway after all mechanical work likely to injure conductors has been completed.
- F. Completely and thoroughly swab raceway system before installing conductors.
- G. Conductors shall not be pulled in concrete encased conduits before concrete is placed.

**3.4 INSTALLATION OF CABLES**

- A. Comply with NECA 1.
- B. Provide protection for exposed cables where subject to damage.
- C. Use suitable cable fittings and connectors.
- D. All cable shall be racked and supported in manholes.
- E. Pulling winches and other necessary pulling equipment shall be of adequate capacity to ensure a continuous pull on the cable. Strain gages shall be used to monitor the

cable pulling tension.

- F. Cable and Wire pulling lubricants that are non-corrosive and harmless to hands and clothes shall be used. Lubricants shall be compatible with cable jackets and insulation.
- G. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
  2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  3. Install 110-style IDC termination hardware unless otherwise indicated.
  4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  5. Cables may not be spliced except at locations noted on the contract drawings.
  6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
  9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  11. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
  12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- H. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
  2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- I. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
  2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
  3. Exterior fiber cables shall be loose tube construction, with water blocking tape in all installations.
- J. Group connecting hardware for cables into separate logical fields.

**K. Separation from EMI Sources:**

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Transformers, 5 kVA and Larger: A minimum of 48 inches (1200 mm).

**3.5 GROUNDING**

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from

grounding bus bar to suitable electrical building ground.

- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling using backbone and inter-building cable numbers as assigned by DEN Technologies Premise Wiring & Communications.

1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

- B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- C. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
  - b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

- D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Torque conductor connections and terminations to manufacturer's recommended values. Provide torque report if requested by DEN Project Manager.
- C. Verify cables are colored coded and labeled according to contract documents.

- D. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- E. Perform tests and inspections.
- F. Tests and Inspections:
1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-B.1.
  2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  4. Optical Fiber Cable Tests:
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    - b. Link End-to-End Attenuation Tests - Single Mode:
      - 1) Perform an optical loss test of each strand using an optical power meter and calibrated light source at both 1310nm and 1550nm..
      - 2) Perform an Optical Time Domain Reflectometer test from both ends of each fiber strand at both 1310nm and 1550nm.
- G. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- H. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- I. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- J. Prepare test and inspection reports.

## **PART 4 - MEASUREMENT**

### **4.1 METHOD OF MEASUREMENT**

- A. Fiber optic cable will be paid the Contract per linear foot installed, complete and in-place, ready for operation, and accepted by the DEN Project Manager. The measurement for this item shall include additional quantities required for slack.

## **PART 5 - PAYMENT**

### **5.1 PAYMENT**

- A. Payment shall be made at the Contract unit price for fiber optic cable installed in ductbank, in-place by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, including splicing, terminations, testing, and incidentals necessary to complete this item.

Payment will be made under:

Item 27 13 00-5.1 Install Fiber Optic Cable, Single Mode, 12-Strand – per linear foot

END OF SECTION 271300

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
271300 – COMMUNICATIONS BACKBONE CABLING**

**DENVER INTERNATIONAL AIRPORT  
DS EAST TAXIWAY  
CONTRACT NO. 201737642-02**

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## SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. UTP cabling.
  - 2. Low-voltage control cabling.
  - 3. Control-circuit conductors.
  - 4. Identification products.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

#### 1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- F. RCDD: Registered Communications Distribution Designer.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data substantiating that materials comply with requirements.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Field quality-control reports.

**1.6 CLOSEOUT SUBMITTALS**

- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

**1.7 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Test cables upon receipt at Project site.
  - 1. Test each pair of UTP cable for open and short circuits.

**1.9 FIELD CONDITIONS**

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
  - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

**1.10 CONSTRUCTION WASTE MANAGEMENT**

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **2.2 UTP CABLE**

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. ADC.
  - 2. AMP Netconnect; a brand of Tyco Electronics Corporation.
  - 3. Belden Inc.
  - 4. Berk-Tek; a Nexans company.
  - 5. CommScope, Inc.
  - 6. Draka Cableteq USA.
  - 7. Genesis Cable Products; Honeywell International, Inc.
  - 8. Mohawk; a division of Belden Networking, Inc.
  - 9. Superior Essex Inc.
  - 10. SYSTIMAX Solutions; a CommScope, Inc. brand.
  - 11. 3M; Communication Markets Division.
  - 12. or approved equal.
- B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties.
  - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
  - 3. Comply with TIA/EIA-568-B.2, Category 5e Category 6.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG.
    - b. Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, complying with UL 1666.

## 2.3 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC.
  2. American Technology Systems Industries, Inc.
  3. AMP Netconnect; a brand of Tyco Electronics Corporation.
  4. Belden Inc.
  5. Dynacom Inc.
  6. Hubbell Incorporated; Hubbell Premise Wiring.
  7. Leviton Commercial Networks Division.
  8. Molex Premise Networks; a division of Molex, Inc.
  9. Panduit Corp.
  10. Siemon.
  11. or approved equal.
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: 110-style for Category 5e 110-style for Category 6 66-style for Category 5e. Provide blocks for the number of cables terminated on the block, plus percent spare. Integral with connector bodies, including plugs and jacks where indicated.

## 2.4 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with UL 1581.

## 2.5 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Worldwide, Inc.
  2. HellermannTyton North America.
  3. Kroy LLC.
  4. Panduit Corp.
  5. or approved equal.

- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All power, control, data, communication and signal wire or cable shall be installed in an approved raceway.
- B. Completely and thoroughly swab raceway system before installing conductors.
- C. Conductors shall not be pulled in concrete encased conduits before concrete is placed.
- D. All cable shall be racked and supported in manholes.
- E. Pulling winches and other necessary pulling equipment shall be of adequate capacity to ensure a continuous pull on the cable. Strain gages shall be used to monitor the cable pulling tension.
- F. Cable and Wire pulling lubricants that are non-corrosive and harmless to hands and clothes shall be used. Lubricants shall be compatible with cable jackets and insulation.
- G. Splice only in accessible junction and outlet boxes

### 3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

### 3.3 WIRING METHOD

- A. Install wiring in metal pathways and wireways.
  - 1. Minimum conduit size shall be 1 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- C. Wiring within Enclosures:
  - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  - 2. Install lacing bars and distribution spools.
  - 3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
  - 4. Install conductors parallel with or at right angles to sides and back of enclosure.
  - 5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
  - 6. Mark each terminal according to system's wiring diagrams.
  - 7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

### 3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
1. Comply with TIA/EIA-568-B.2.
  2. Install 110-style IDC termination hardware unless otherwise indicated.
  3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- E. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
  3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  5. Separation between Cables and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

### 3.5 CONNECTIONS

- A. Comply with requirements in Section 282300 "Video Surveillance" for connecting, terminating, and identifying wires and cables.

### 3.6 GROUNDING

- A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

#### **PART 4 - MEASUREMENT**

##### 4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

#### **PART 5 - PAYMENT**

##### 5.1 PAYMENT

- A. Conductors and Cables for Electronic Safety and Security shall be considered necessary and incidental to the work of this Contract.

**END OF SECTION 280513**

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
280513 – CONDUCTORS AND CABLES FOR ELECTRONIC  
SAFETY AND SECURITY**

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**DENVER INTERNATIONAL AIRPORT  
DS EAST TAXIWAY  
CONTRACT NO. 201737642-02**

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## **SECTION 282300 - VIDEO SURVEILLANCE**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Contractor shall provide all skilled labor, material, and equipment for the complete installation of the Video Surveillance System additions and modifications as shown on the drawings and specified herein. The Video Surveillance System on this Project is an extension of the existing Genetec Omnicast 4.8 system. The Contractor shall acquire from the manufacturer the installation practices as published by the Manufacturer.

Work includes:

1. IP Cameras.
2. Cabling.

The Contractor shall be responsible to provide a complete installation in compliance with DEN requirements, Denver Building Codes, and Denver Fire Prevention Bureau requirements. DEN will perform all required headend programming. Testing shall be performed jointly by the Contractor, DEN and the Premise Wiring and Communications (PWCS) Contractor. Refer to the Responsibility Matrix detailed in the Contract Drawings for further clarification regarding the delineation in the scope of work. Coordinate all work through the DEN Project Manager.

- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  1. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
  1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
  2. Wiring Diagrams: For power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

A. Field quality-control reports.  
Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Hard copies of manufacturer's specification sheets and PDF files on CD-ROM of the hard-copy submittal.
  2. Include letter from manufacturer's representative stating that system is operational.
- B. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name, and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1. Contractor shall maintain on site accurate as-built drawings indicating dimensioned locations of constructed raceway, box, and device locations. Any modifications to work depicted on the Engineered shop drawings shall be noted. Documents shall be updated daily and shall at all times be available for DEN review.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Comply with NECA 1.

Comply with NFPA 70.

Contractor shall be fully responsible for daily quality control of all system installation, coordination with trades, and coordination with DEN Security and DEN Technical Maintenance.

Installer Qualifications: Company with factory-trained and certified personnel specializing in digital closed circuit television systems with three (3) years' documented experience as a digital

CCTV installing contractor.

## 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 3R enclosures.
  2. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. All products:
1. Store in temperature-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C).
  2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
  3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Minimum three (3) years from date of Substantial Completion.
  2. Warranty service shall be provided by a trained specialist of the equipment manufacturer, who shall be based in a fully staffed, fully stocked (replacement parts and test equipment) office, located within 50 miles of the site.

## 1.11 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to

satisfy the requirements of that Section.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. All equipment and materials used shall be new, standard components, regularly manufactured, regularly utilized in the manufacturer's system.

All systems and components shall have been thoroughly tested and proven in actual use.

### **2.2 CAMERAS**

A. General Requirements

1. Power: POE preferred. Refer to specified models for individual requirements and drawings for additional information. For POE+ and UPOE coordinate with engineer and DEN project manager. Contractor shall verify voltage requirements for all cameras, prior to shop drawing submittal, based on the camera power requirements as well as directions on the plans and schedules. No additional compensation will be provided due to failure of compliance with requirements.
2. Video: H.264 required, motion JPEG capable.
3. Network:
  - a. IPv4/v6, HTTP, HTTPS, SSL/TLS, SMTP, SNMP
  - b. Multi-level password, IP filter, HTTPS encryption, IEEE 802.1x
4. Audio – Not required at all locations. Refer to specified models for standard and drawings for additional information.
5. Environment – Location specific
6. Mounting – Surface, wall, ceiling, corner, parapet, or other as shown on drawings. Coordinate camera mounting with the architectural ceiling plans, sections and elevations. Provide all mounting hardware including trim and flanges to complete the installation.

- B. Approved cameras: As manufactured by AXIS Communications or approved equal. See below for procedure required to submit product for approval as equal. The model number indicates the type of camera with its minimum requirements and does not include accessories required or environment intended (indoor, outdoor, industrial, etc.) Standard cameras used at DEN are as follows.

1. Fixed: P3265-LVE
2. PTZ: Q6075 (Interior) Q6075-E (Exterior)
3. 180 Degree: P3807-PVE
4. 360 Degree: M3057-PLVE MK II
5. 360 Degree with Audio: M3077-PLVE

- C. Contractor shall submit shop drawings for the cameras indicating all required accessories as shown on the drawings and in the specifications. Whether specified by the catalog numbers or not, the contractor shall provide all components, hardware and related items to provide a complete and operational system to meet the requirements as specified in the drawings and specifications.

A product from a manufacturer not listed may be submitted for approval during the shop drawing phase. Requests for substitutions will not be approved after the shop drawing phase. The product must be equal in physical attributes, and meet or exceed quality and performance requirements, without exceeding the capabilities of existing infrastructure. The A/E's determination for the approval shall govern. Provide complete detail of the proposed equal camera with a detailed comparison to the specified camera including any additional information requested by the A/E. Prototype products shall not be submitted for approval as equal to specified products.

### 2.3 CABLES

- A. General Cable Requirements: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

Cable conductors shall be stranded copper. Provide cable with chrome gray PVC jacket and UL-CMP listing.

Approved Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Belden, West Penn.
2. Approved equal.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. The Contractor shall coordinate and arrange a pre work meeting with the DEN Project Manager, DEN Project Inspectors, DEN Security, and DEN Technical Maintenance one (1) week in advance of the beginning of any work. The DEN Project Manager shall review the Contractor's construction demolition, phasing, implementation, and testing plans and schedule.
- B. Meeting Notes: Meeting notes shall be accurately recorded by the DEN Project Manager and distributed within five (5) working days after the meeting.

### 3.2 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

Examine roughing-in for LAN, WAN, and IP network before device installation.

Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 GENERAL

- A. Installation shall be supervised and tested by a representative of the manufacturer of the system equipment. The Work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this Work.

Raceways: Raceways shall be installed in accordance with Item L-110.

Wire and Cable: All wiring and cable shall be installed in metal raceways or within equipment. Splices shall not be allowed. Conductors within equipment enclosures shall be carefully cabled and laced. Individual cables shall be tagged with markers indicating circuit number and type. Markers shall be used and numbered according to Cabling Schedule with cable numbers on all conductors at each outlet or pull box at each equipment enclosure.

### 3.4 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

### 3.5 GROUNDING

- A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

Bond shields and drain conductors to ground at only one point in each circuit.

Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### 3.6 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras level and plumb.

Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.

Install power supplies and other auxiliary components unless otherwise indicated.

Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."

### 3.7 INTERFACE WITH OTHER SYSTEMS

- A. Interface programming of closed circuit television system with computerized card access system shall be by DEN Technical Maintenance and/or DEN Security. Coordinate all Work through DEN Project Manager.

### 3.8 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-A.
- B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

### 3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare

video-surveillance equipment for acceptance and operational testing as follows:

- a. Verify operation of auto-iris lenses.
  - b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
  - c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
  - d. Set and name all preset positions; consult Owner's personnel.
  - e. Set sensitivity of motion detection.
  - f. Connect and verify responses to alarms.
  - g. Verify operation of control-station equipment.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
  4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
  5. A representative of the installing Contractor shall submit a written report of the findings to the DEN Project Manager. Representative shall be factory trained and certified and have at least three (3) years' experience installing access control systems.
    - a. Report shall consist of a complete listing of every device and feature, the date it was tested and by whom, the results, and the date retested (if failure occurred during any previous tests). The final test reports shall indicate that every device tested successfully. Submit two typed copies of the test reports in a neatly bound folder to the DEN Project Manager for approval. Failure to comply will result in a delay of final testing and acceptance.
  6. Design engineer and DEN Project Manager will witness all field tests.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports.

### 3.10 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.

## PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Cameras will be paid the Contract per type installed, complete and in-place, ready for operation, and accepted by the DEN Project Manager.

**PART 5 - PAYMENT**

5.1 PAYMENT

- A. Payment shall be made at the Contract unit price per each for each item completed in accordance with the plans and specifications, in-place by the Contractor and accepted by the DEN Project Manager. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, including calibration, aiming, telecom enclosure, equipment in the telecom enclosure, patch panels, patch cables, minipower center, cable feeding minipower center, cable and conduit from minipower center to telecom enclosure, UTP cable between telecom enclosure and cameras, terminations, testing and incidentals necessary to complete this item.

Payment will be made under:

- Item 28 23 00-5.1 Install PTZ and Fixed Lens Camera on High Mast Light Pole – per each

END OF SECTION 282300

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**TECHNICAL SPECIFICATIONS  
DIVISION 2 – AIRFIELD STANDARDS  
SECTION 282300 – VIDEO SURVEILLANCE**

**DENVER INTERNATIONAL AIRPORT  
TAXIWAY DS EAST  
CONTRACT NO. 201737642-02**

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**EXHIBIT J**

**CONTRACT DRAWINGS**

**Denver International Airport  
Contract No. 202366450**

**Flatiron Constructors, INC.  
Taxiway DS East and Deicing Pad**

**Incorporated by Reference as found in File #20230038  
at the Denver Office of the Clerk and Recorder**

**EXHIBIT K**

**INVITATION FOR BID AND CONTRACTOR'S  
RESPONSE TO INVITATION FOR BID**

**Denver International Airport  
Contract No. 202366450**

**Flatiron Constructors, INC.  
Taxiway DS East and Deicing Pad**

**Incorporated by Reference as found in File #20230039  
at the Denver Office of the Clerk and Recorder**