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 **MILLSTONE WEBER, LLC**, a Missouri limited liability company authorized to do business in the State of Colorado ("**Contractor** ") (collectively the "**Parties**").

W I T N E S S E T H

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 No. 202474451-00, GARDI A Southeast at Denver International Airport ("**DEN**"); and

WHEREAS, a proposal in response to said advertisement have been received by the Chief Executive Officer of DEN (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 work 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 City 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 32 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 City Equal Employment Opportunity Provisions
6. Exhibit E Special Conditions
7. Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the "**Yellow Book**") ("**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, Design, Engineering and Construction (the "**SVP**") 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 240 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 **Fourteen Million Five Hundred Seventy-Seven Thousand Two Hundred Ninety-Three Dollars and Five Cents ($14,577,293.05)** (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 ("**C.R.S.**") § 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 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 ("**D.R.M.C.**") § 5-17 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 under this Contract.

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. 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 June 28, 2024.

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.

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 Contract. 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 and 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 MWBE Subcontractors. For contracts of one million dollars ($1,000,000.00) and over to which D.R.M.C. § 28-72 applies, the Contractor is required to comply with the Prompt Payment provisions under D.R.M.C. § 28-72, with regard to payments by the Contractor to MWBE subcontractors. If D.R.M.C.§ 28-72 applies, Contractor shall make payment by no later than thirty-five (35) days from receipt by the 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 Agreement, provision of any goods or services to the City, and any other transactions related to this Agreement. 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 three (3) years after the final payment under the Agreement or expiration of the applicable statute of limitations. When conducting an audit of this Agreement, 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 audit pursuant to this paragraph shall require Parties to make disclosures in violation of state or federal privacy laws. Parties 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. COMPLIANCE WITH DENVER WAGE LAWS:

To the extent applicable to the Contractor's work hereunder, the Contractor shall comply with, and agrees to be bound by, all rules, regulations, requirements, conditions, and City determinations regarding the City's Minimum Wage and Civil Wage Theft Ordinances, D.R.M.C § 58-1 through 58-26, including, but not limited to, the requirement that every covered worker shall be paid all earned wages under applicable state, federal, and city law in accordance with the foregoing D.R.M.C. Sections. By executing this Agreement, the Contractor expressly acknowledges that the Contractor is aware of the requirements of the City's Minimum Wage and Civil Wage Theft Ordinances and that any failure by the Contractor, or any other individual or entity acting subject to this Agreement, to strictly comply with the foregoing D.R.M.C. Sections shall result in the penalties and other remedies authorized therein.

26. COMPLIANCE WITH MINORITY/WOMEN BUSINESS ENTERPRISE REQUIREMENTS:

A. This Agreement is subject to Article III, Divisions 1 and 3 of Chapter 28, D.R.M.C., designated as §§ 28-31 to 28-40 and 28-51 to 28-90 (the "**DSBO Ordinance**"); and any Rules and Regulations promulgated pursuant thereto. The contract goal for MWBE participation established for this Agreement by the Division of Small Business Opportunity ("**DSBO**") is 17%.

B. Under D.R.M.C., § 28-68, the Contractor has an ongoing, affirmative obligation to maintain for the duration of this Agreement, at a minimum, compliance with the MWBE participation upon which this Agreement was awarded, unless the City initiates a material modification to the scope of work affecting MWBEs performing on this Agreement through change order, contract amendment, force account, or other modification under D.R.M.C. § 28-70. The Contractor acknowledges that:

(i) If directed by DSBO, the Contractor is required to develop and comply with the Equity, Diversity and Inclusion Plan ("**EDI Plan**") attached as ***Exhibit L*** and as it may be modified in the future by DSBO. Unless a separate Utilization Plan is required in accordance with D.R.M.C. § 28-62(b), the EDI Plan shall constitute the Utilization Plan required by D.R.M.C. § 28-62(b). Along with the EDI Plan and Utilization Plan requirements, the Contractor must establish and maintain records and submit regular

reports, as directed by DSBO, which will allow the City to assess progress in complying with the EDI Plan and/or Utilization Plan and achieving the MWBE participation goal. The EDI Plan and Utilization Plan is subject to modification by DSBO.

(ii) If change orders or any other contract modifications are issued under the Agreement, the Contractor shall have a continuing obligation to promptly inform DSBO in writing of any agreed upon increase or decrease in the scope of work of such contract, upon any of the bases under D.R.M.C. § 28-70, regardless of whether such increase or decrease in scope of work has been reduced to writing at the time of notification of the change by the City.

(iii) If change orders or other amendments or modifications are issued under the contract that include an increase in the scope of work of this Agreement, whether by amendment, change order, force account or otherwise, which increases the dollar value of the contract, whether or not such change is within the scope of work designated for performance by an MWBE at the time of contract award, such change orders or contract modification shall be promptly submitted to DSBO for notification purposes.

(iv) Those amendments, change orders, force accounts or other contract modifications that involve a changed scope of work that cannot be performed by existing project subcontractors are subject to the original contract goal. The Contractor shall satisfy the goal with respect to such changed scope of work by soliciting new MWBEs in accordance with D.R.M.C. § 28-70. The Contractor must also satisfy the requirements under D.R.M.C. §§ 28-60 and 28-73, with regard to changes in scope or participation. The Contractor shall supply to DSBO all required documentation under D.R.M.C. §§ 28-60, 28-70, and 28-73, with respect to the modified dollar value or work under the contract.

(v) If applicable, for contracts of one million dollars ($1,000,000.00) and over, the Contractor is required to comply with D.R.M.C. § 28-72, regarding prompt payment to MWBEs. Payment to MWBE subcontractors shall be made by no later than thirty-five (35) days after receipt of the MWBE subcontractor's invoice.

(vi) Termination or substitution of an MWBE subcontractor requires compliance with D.R.M.C. § 28-73.

(vii) Failure to comply with these provisions may subject the Contractor to sanctions set forth in § 28-76 of the DSBO Ordinance.

(viii) Should any questions arise regarding specific circumstances, the Contractor should consult the DSBO Ordinance or may contact the Project's designated DSBO representative at (720) 913-1999.

27. GENERAL TERMS:

A. Use, Possession or Sale of Alcohol or Drugs. Contractor shall cooperate and comply with the provisions of Denver 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 barring Contractor from City facilities or participating in City operations.

B. City Smoking Policy. Contractor and its officers, agents and employees shall cooperate and comply with the provisions of Denver Executive Order No. 99 and the Colorado Indoor Clean Air Act, prohibiting smoking in all City buildings and facilities.

28. 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.

29. 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 Transportation Security Administration ("**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.F.R. 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.

30. 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.

31. 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.

32. 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-202474451-00
Contractor Name: MILLSTONE WEBER, LLC

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:

Attorney for the City and County of Denver

By: _____

REGISTERED AND COUNTERSIGNED:

By: _____

By: _____

Contract Control Number: PLANE-202474451-00
Contractor Name: MILLSTONE WEBER, LLC

By: Signed by: Thomas Kuhn 14B6324CDE0743D... _____

Name: Thomas Kuhn _____
(please print)

Title: CEO _____
(please print)

ATTEST: [if required]

By: _____

Name: _____
(please print)

Title: _____
(please print)

EXHIBIT A

Standard Federal Provisions – (Non-AIP Funded)

GENERAL CIVIL RIGHTS PROVISIONS

The Contractor or Consultant 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 the Contractor and subcontractors from the bid solicitation period through the completion of the contract. This provision is in addition to that required by Title VI of the Civil Rights Act of 1964.

COMPLIANCE WITH NONDISCRIMINATION REQUIREMENTS:

During the performance of this contract, the Contractor or Consultant, for itself, its assignees, and successors in interest (hereinafter collectively 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.

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).

FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)

Contractor is responsible for complying with the Federal Fair Labor Standards Act and for monitoring compliance by its subcontractors. Contractor must address any claims or disputes that arise from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

All contracts and subcontracts that result from this solicitation incorporate by reference the requirements of 29 CFR 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 their subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (20 CFR 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.

RULES AND REGULATIONS

REGARDING

EQUAL EMPLOYMENT OPPORTUNITY

Promulgated and adopted by the Executive Director of the Department of Transportation and Infrastructure 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 subject 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 Executive Director of the Department of Transportation and Infrastructure 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 Division of Small Business Opportunity.

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 III, 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. "Division of Small Business Opportunity" 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 (10) 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 Division of Small Business Opportunity 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 the 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.

REGULATION NO. 3 - DIRECTOR OF CONTRACT COMPLIANCE:

The Director of the Division of Small Business Opportunity shall perform the duties assigned to such official by Article III, Division 2 Chapter 28 of the Revised Municipal Code and by the Manager. (1) The Director of the Division of Small Business Opportunity 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 Division of Small Business Opportunity; 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 Division of Small Business Opportunity 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 Division of Small Business Opportunity 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 the Notice to Proceed a sign-off will be required of the Director of the Division of Small Business Opportunity 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.

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 and 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 Denver Revised Municipal Code, he may issue a notice requiring the contractor to show cause, within fifteen (15) 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 Transportation and Infrastructure, 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 of Chapter 28 of the Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager and the Director.

5. The Contractor will furnish all information and reports required by Article III, Division 2 of 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 canceled, 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 of 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 on each subcontractor or supplier. 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.

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 of 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

AFFIRMATIVE ACTION REQUIREMENTS

EQUAL EMPLOYMENT OPPORTUNITY

For All Non-Exempt Construction Contracts to Be Awarded by the
City and County of Denver, Department of Transportation and Infrastructure.

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.

/s/_____

Executive Director of Transportation and Infrastructure
City and County of Denver

A. REQUIREMENTS - AN AFFIRMATIVE 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 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	GOALS FOR FEMALE PARTICIPATION FOR EACH TRADE
From January 1, 1982 to Until Further Notice	From January 1, 1982 to Until Further Notice
21.7% - 23.5%	**6.9%**

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.

* "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 Transportation and Infrastructure, and the Division of Small Business Opportunity 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 Division of Small Business Opportunity 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.

B. 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 of 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 III, Division 2 of 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 Transportation and Infrastructure in determining whether such contractor can comply with the requirements of Article III, Division 2 of Chapter 28 of the Revised Municipal Code, and is therefore a "responsible prospective contractor".

3. The Division of Small Business Opportunity shall review the Contractor's employment practices during the performance of the contract. If the Division of Small Business Opportunity determines that the Contractor's Affirmative Action Plan is no longer an acceptable program, the Director shall notify the Manager.

C. 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 of Chapter 28 of the Revised Municipal Code. It is the policy of the Department of Transportation and Infrastructure 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.

D. 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 III, 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 III, 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 the Department of Transportation and Infrastructure, 201 W. Colfax, Dept. 608, 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

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
- 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 sold, 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 it is 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 ROCP 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.

Exhibit D

City and County of Denver

TIMOTHY M. O'BRIEN, CPA
AUDITOR

201 West Colfax Avenue, #705 • Denver, Colorado 80202
(720) 913-5000 • Fax (720) 913-5253 • denvergov.org/auditor

TO: All Users of the City and County of Denver Prevailing Wage Schedules
FROM: Luis Osorio Jimenez, Prevailing Wage Administrator
DATE: June 12, 2024
SUBJECT: Latest Change to Prevailing Wage Schedules

The effective date for this publication will be, **Wednesday, June 12, 2024,** and applies to the City and County of Denver for **HIGHWAY CONSTRUCTION PROJECTS** (does not include residential construction consisting of single family homes and apartments up to and including 4 stories) in accordance with the Denver Revised Municipal Code, Section 20-76(c).

General Wage Decision No. CO 20240009
Superseded General Decision No. CO 20230009
Modification No. 1
Publication Date: 5/31/2024
(9 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.

In accordance to the amendment of Section 20-76, Division 3, Article IV, Chapter 20 of the Denver Revised Municipal Code enacted on Aug 21st, 2023, the Prevailing Wage Administrator is authorized to approve and adjust all Davis Bacon classifications under $18.29 to comply with the city's minimum wage. Contractors will also have to comply with the established Minimum Wage of $18.29 for all apprentice classifications as base rate. Fringes will be added in to the base rate amount.

"General Decision Number: CO20240009 05/31/2024

Superseded General Decision Number: CO20230009

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)(1).

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 $18.29 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 2024.
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 $18.29 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 2024.	

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 wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker
protections under the Executive Orders is available at
http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/05/2024
1	05/31/2024

* CARP9901-008 05/01/2024

	Rates	Fringes
CARPENTER (Form Work Only).....	$ 33.11	12.10

ELEC0068-016 03/01/2011

	Rates	Fringes
TRAFFIC SIGNALIZATION:		
Traffic Signal Installation		
Zone 1.....	$ 26.42	4.75%+8.68
Zone 2.....	$ 29.42	4.75%+8.68

TRAFFIC SIGNAL INSTALLER ZONE DEFINITIONS

Zone 1 shall be a 35 mile radius, measured from the following addresses in each of the following cities:
Colorado Springs - Nevada & Bijou
Denver - Ellsworth Avenue & Broadway
Ft. Collins - Prospect & College
Grand Junction - 12th & North Avenue
Pueblo - I-25 & Highway 50
All work outside of these areas shall be paid Zone 2 rates.

ENGI0009-008 05/01/2023

	Rates	Fringes
POWER EQUIPMENT OPERATOR:		

(3)-Hydraulic Backhoe (Wheel Mounted, under 3/4 yds), Hydraulic Backhoe (Backhoe/Loader combination), Drill Rig Caisson (smaller than Watson 2500 and similar), Loader (up to and including 6 cu. yd.).....	$ 33.14	14.20
(3)-Loader (under 6 cu. yd.) Denver County.....	$ 33.14	14.20
(3)-Motor Grader (blade-rough) Douglas County.....	$ 33.19	14.20
(4)-Crane (50 tons and under), Scraper (single bowl, under 40 cu. yd).....	$ 33.83	14.20
(4)-Loader (over 6 cu. yd) Denver County.....	$ 33.30	14.20
(5)-Drill Rig Caisson (Watson 2500 similar or larger), Crane (51-90 tons), Scraper (40 cu.yd and over),.....	$ 33.48	14.20
(5)-Motor Grader (blade-finish) Douglas County.....	$ 33.65	14.20
(6)-Crane (91-140 tons).....	$ 35.28	14.20

* 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)	$ 18.29 **	3.20
GUARDRAIL INSTALLER	$ 18.29 **	3.20
HIGHWAY/PARKING LOT STRIPING:Painter		
Denver	$ 18.29 **	3.21
Douglas	$ 18.29 **	3.21
IRONWORKER, REINFORCING (Excludes Guardrail Installation)	$ 55.25 **	3.65
IRONWORKER, STRUCTURAL (Includes Link/Cyclone Fence Erection, Excludes Guardrail Installation)	$ 55.25	3.65
LABORER		
Asphalt Raker	$ 18.29 **	4.25
Asphalt Shoveler	$ 21.21	4.25
Asphalt Spreader	$ 18.58	4.65
Common or General		
Denver	$ 18.29 **	6.77
Douglas	$ 18.29 **	4.25
Concrete Saw (Hand Held)	$ 18.29 **	6.14
Landscape and Irrigation	$ 18.29 **	3.16
Mason Tender-Cement/Concrete		
Denver	$ 18.29 **	4.04
Douglas	$ 18.29 **	4.25
Pipelayer		
Denver	$ 18.29 **	2.41
Douglas	$ 18.29 **	2.18
Traffic Control (Flagger)	$ 18.29 **	3.05
Traffic Control (Sets Up/Moves Barrels, Cones, Install Signs, Arrow Boards and Place Stationary Flags)(Excludes Flaggers)	$ 18.29	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	$ 18.29	**	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	$ 18.29	**	4.68
Grader/Blade			
Denver	$ 22.67		8.72
Guardrail/Post Driver	$ 18.29	**	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	$ 18.29	**	4.41
Screed			
Denver	$ 22.67		8.38
Douglas	$ 29.99		1.40
Tractor	$ 18.29	**	2.95
TRAFFIC SIGNALIZATION:			
Groundsman			
Denver	$ 18.29		3.41

Douglas	$ 18.67		7.17
TRUCK DRIVER			
Distributor			
Denver	$ 18.29		5.82
Douglas	$ 18.29	**	5.27
Dump Truck			
Denver	$ 18.29	**	5.27
Douglas	$ 18.29	**	5.27
Lowboy Truck	$ 18.29		5.27
Mechanic	$ 26.48		3.50
Multi-Purpose Specialty & Hoisting Truck			
Denver	$ 18.29		3.17
Douglas	$ 20.05		2.88
Pickup and Pilot Car			
Denver	$ 18.29	**	3.77
Douglas	$ 18.29	**	3.68
Semi/Trailer Truck	$ 18.39		4.13
Truck Mounted Attenuator	$ 18.29	**	3.22
Water Truck			
Denver	$ 26.27		5.27
Douglas	$ 19.46		2.58

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

Office of the Prevailing Wage
Administrator for Supplemental Rates
(Specific to Denver projects)
Revision Date 01-01-2024

Classification		Base	Fringe
Guard Rail Installer		$18.29	$3.20
Highway Parking Lot Striping: Painter		$18.29	$3.21
Ironworker (Ornamental)		$26.05	$12.00
Laborer	Removal of Asbestos	$21.03	$8.55
Laborer (Landscape & Irrigation)		$18.29	$3.16
Laborer: Traffic Control (Flagger)		$18.29	$3.05
Laborer: Stationary Flags (excludes Flaggers)		$18.29	$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		$18.29	$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

IFB 202474451 – GARDI A SOUTHEAST

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 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–1 REVISIONS TO GC 201

The second sentence of General Condition 201 is amended to read: "The unit responsible for this management and control is the Department of Aviation (DEN) Design, Engineering & Construction Division (DEC) under the supervision of the Senior Vice President for Design, Engineering and Construction Division."

SC–2 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. Design, Engineering & Construction office, 9th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

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

Director reports to the SVP-DEC. The Project Manager reports to the Director of Infrastructure and Quality Assurance. Design, Engineering & Construction Division, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Project Manager is the City representative who has day to day administrative responsibility of this Contract, and who reports to the SVP-DEC. 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: Clint Sciacca and Hunter Wardlaw, Design, Engineering and Construction Office, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

The CEO may from time to time substitute a different City official as the designated "SVP-DEC" hereunder, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor SVP-DEC. The SVP-DEC 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–3 N/A

SC–4 CLARIFICATION TO GC 501 CONTRACTOR PERFORMANCE; SUBCONTRACTING

With respect to General Condition 501, no more than seventy five percent (75%) 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-DEC.

SC–5 REVISIONS TO GC 902. APPLICATIONS FOR PROGRESS PAYMENTS TO CONTRACTORS

General Condition 902.3 is amended by the addition of the following:

Where applicable, with respect to any Task Order issued hereunder, progress payments for the performance of any work shall be based on completed work estimates and shall be subject to the following requirements:

1. The Contractor shall submit a complete and separate application for Payment for the work estimates of each Task Order performed during the specified billing period.
2. Each submitted estimate shall specify the percent of the Work completed. The quantity shall be those identified in the SOV and certified by the Project Engineer/Manager or the Consulting Architect or Engineer, as appropriate.
3. Each estimate of Work completed shall also specifically identify those MWBE Subcontractors or Suppliers that the Contractor is utilizing on the Project pursuant to the requirements of Article VII, Division 1 and 3 of Chapter 28 of the DRMC.
4. Each estimate of Work for each Task Order performed shall be submitted using a separate Application for Progress Payment Task Order Contracts (Form CM-18A), accompanied by either duplicate sets of verified Contractor's Certifications of Payment (Form CM-19) or by verified Release of Contractor forms from each subcontractor and supplier. Each estimate of Work completed shall also be accompanied by the following:
    a. A written schedule of values, which sets out the quantities and costs for the Project and
    b. The Project Engineer/Manager's, or Consulting Architect or Engineer, as applicable, Architect's or Engineer's estimated statement of the percentage of Work completed for each line item of cost for which the City has promised to pay the Contractor. The Contractor shall also submit to the Auditor and other appropriate officials of the City, in a timely fashion, all information required by General Conditions Title 9.
5. The estimate of the percentage of estimated Work completed shall constitute a representation by the Contractor to the City that the Work has progressed to the point indicated; that the quality of the Work covered by the estimate is in accordance with the Contract Documents; that each obligation covered by the estimate (except as otherwise noted), and the payments required will be used to discharge such obligation unless previously discharged; and that the Contractor is entitled to Payment in the amount requested. The Project Engineer/Manager or

the Consulting Architect or Engineer, as appropriate, with the assistance of input from the Project Construction Manager, in the event that such has been retained, will also verify the estimate of Work completed prior to any acceptance by the City.

6. The Contractor warrants that:
    a. Title to Work covered by an estimate of Work completed will pass to the City by incorporation into the completed Work;
    b. Work covered by previous estimates of Work completed is free and clear of liens, claims, security interests, or encumbrances, hereinafter referred to as "liens," except for any interest created by retainage; and
    c. No work covered by an estimate of Work completed will have been acquired by the Contractor or any other person or entity performing Work at the work site or furnishing materials or equipment for the Project, and no work covered by any estimate is subject to an agreement under which an interest therein or an encumbrance thereon is retained by the seller or otherwise imposed by the Contractor or such other person or entity.
7. Approval of an estimate of Work completed or actual Payment shall not foreclose the right of the City to examine the books and records of the Contractor to determine the correctness and accuracy of any estimate item.
8. The final estimate for Payment shall also be accompanied by Final Lien Release forms from each subcontractor and supplier (Form CM-70).

SC–6 REVISIONS TO GC 907 SUBCONTRACTOR RELEASES (Not Applicable)

SC–7 REVISIONS TO GC 1102

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

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

SC–8 REVISIONS TO GCs 1501, 1502, & 1503 PERFORMANCE AND PAYMENT BOND

Delete the requirements of General Contract Conditions 1501, 1502, and 1503 for separate bonds. Combined Performance and Payment Bonds in the total amount of all current outstanding Task Orders, provided in the precise form contained in these documents, shall be furnished before any work is undertaken in connection with any Task Order. All other terms and conditions of General Contract Conditions 1501, 1502, and 1503 shall remain in effect.

SC–9 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:

A. GARDI A Southeast IFB Drawings – 6.14.24
B. GARDI A Southeast Division I Specifications – 6.14.24
C. GARDI A Southeast Division II Specifications – 6.14.24

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.

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

SC–10 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 Federal Aviation Administration (FAA) or City requirements while performing work on DEN property.

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.

Contract Number	Description
TBD	Annual Airfield Pavement Rehabilitation
TBD	Delta Apron Improvements

SC–11 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 240 consecutive calendar days from Notice to Proceed (NTP).

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.

	Milestone	Date of Completion (or days from NTP)
1.	Phase 1 (A40, A42)	120 calendar days from NTP
2.	Phase 2 (A44, A46)	240 calendar days from NTP

SC–12 LIQUIDATED DAMAGES

If the Contractor fails to achieve Substantial Completion of the Work within the Contract Time, the Contractor shall be liable to the City for liquidated damages at the rate of Five Thousand Dollars ($5,000.00) per day until substantial completion is achieved.

	Milestone	Liquidated Damages, Per Day
1.	Phase 1 (A40, A42)	$5,000 per Calendar Day
2.	Phase 2 (A44, A46)	$5,000 per Calendar Day

Section 9 of the of the Contract and General Condition 602 cover payment and withholding of liquidated damages.

SC–13 FACILITY SECURITY AND PERSONNEL ACCESS

The Contractor shall conduct its activities at the Airport in compliance with the Airport Security 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 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 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 and 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-14 CONSTRUCTION ACCESS

The work site is located at Concourse A Gates A40, A42, A44, & A46. The Contractor shall have access to the work site via the haul route designated on the project drawings. The Contractor is responsible for ensuring 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–15 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–16 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–17 COMMUNICATION DEVICES

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

SC-18 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS

Referenced in body of the Agreement

SC-19 ATTORNEY FEES

Referenced in body of the Agreement

SC–20 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 (CCD) 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 Exhibit C. 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. 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–21 SUBCONTRACTOR RELEASES

The Partial Claim Release requirement referred to in General Condition 907 has been waived by the EVP-CCIO. A Contractor's Certification of Payment (CCP) completed by Contractor for the previous month's payment ina format acceptable to the Project Manager is still required.

The term ‘subcontractor’ includes a labor pool.

SC–22 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS

Referenced in body of the Agreement

SC-23 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-24 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-25 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-26 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–27 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-28 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 the Contractor's Certification of Payment Form. A Final Claim Release Form from EACH subcontractor and supplier must be submitted with the Contractor's Final Application for Payment.

SC–29 DESIGN ACTIVITIES

Certain tasks on this Contract may require the Contractor to include Design activities. In this case, the professional service is listed as a sub-contractor. It is assumed that the Contractor will correct any professional liability claims made by DEN. The Contractor will submit reviews of any design in accordance with the Task Order scope of Work and per Design Standards Manuals found at this link: http://business.flydenver.com/bizops/bizRequirements.asp

SC–30 CONTRACTOR SUPERINTENDENT

General Contract Condition 307 is hereby deleted in its entirety and replaced with the following:

The Contractor shall employ and designate to DEN in writing a competent Construction Project Manager, Construction Manager (Project Superintendent), Quality Manager, Traffic Control Manager, and Environmental Manager. The qualifications of these staff must be acceptable to DEN. The Superintendent shall serve on a full-time basis at the Work site and shall be authorized to act on behalf of the Contractor in all matters related to the Work. The same person shall continue in their defined roles until the Work has been completed, unless DEN requests or approved replacement, or they cease to be employed by the Contractor The Superintendent, or their approved designated representative must be onsite at all times when on-site Work is performed.

SC–31 SUBSTANTIAL COMPLETION

General Contract Condition 119 is hereby deleted in its entirety and replace with the following:

“Substantial Completion” of the Work means the Work has progressed to the point that DEN can beneficially occupy and utilize the Work for the purposes for which it is intended, and the Work complies with all applicable codes and regulations, including, if required, issuance of a certificate of occupancy, or certification of suitability for use from the appropriate governmental agencies, as determined by the Project Manager in their sole discretion. Substantial Completion includes, without limitation, the achievement of the following specific conditions: (1) the full and operational status of all drainage elements, (2) all roadways and accesses are complete and open to traffic, (3) all permanent striping, signals and lighting are complete and operational and traffic is in its final configuration, (4) all landscaping is installed with native natural area landscaping seeded with the appropriate Best Management Practices (BMPs) installed, and (5) all Work is in compliance with all applicable laws and the Contract Documents. The achievement of Substantial Completion shall be determined by the Project Manager in their sole discretion. The Project Manager will advise the Contractor in writing when Substantial Completion of the Work has been achieved.

EXHIBIT F

City and County of Denver

DENVER
THE MILE HIGH CITY

DEPARTMENT OF AVIATION
DEPARTMENT OF PUBLIC WORKS

STANDARD SPECIFICATIONS FOR CONSTRUCTION
GENERAL CONTRACT CONDITIONS

2011 Edition

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Exhibit G

BOND #30219664

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned Millstone Weber, LLC, a corporation organized under the laws of the State of Missouri, hereinafter referred to as the "Contractor" and Western Surety Company, a corporation organized under the laws of the State of South Dakota, 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 Fourteen Million Five Hundred Seventy Seven Thousand Two Hundred Ninety Three and 05/100 Dollars ($ 14,577,293.05), 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. 202474451, GARDI A Southeast, 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 ____ day of _____, _____.

Millstone Weber, LLC
601 Fountain Lakes Blvd.
St. Charles, MO 63301
CONTRACTOR

By:_____
President Christopher Gottman

Western Surety Company
151 N. Franklin Street
Chicago, IL 60606
SURETY

By:_____
Attorney-in-Fact
Dana A. Johnessee, 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

Exhibit H

BOND #30219664

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned Millstone Weber, LLC, a corporation organized under the laws of the State of Missouri, hereinafter referred to as the "Contractor" and Western Surety Company, a corporation organized under the laws of the State of South Dakota, 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 Fourteen Million Five Hundred Seventy Seven Thousand Two Hundred Ninety Three & 05/100 Dollars ($ 14,577,293.05), 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. 202474451, GARDI A Southeast, 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 ____ day of _____, _____.

Millstone Weber, LLC
601 Fountain Lakes Blvd.
St. Charles, MO 63301
CONTRACTOR

By:_____
President, Christopher Gottman

Western Surety Company
151 N. Franklin Street
Chicago, IL 60606
SURETY

By:_____
Attorney-in-Fact
Dana A. Johnessee, 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

State of **Missouri**
County of **St. Louis**

On _____, before me, a Notary Public in and for said County and State, residing therein, duly commissioned and sworn, personally appeared **Dana A. Johnessee** known to me to be Attorney-in-Fact of

Western Surety Company

the corporation described in and that executed the within and foregoing instrument, and known to me to be the person who executed the said instrument in behalf of said corporation, and he duly acknowledged to me that such corporation executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year stated in this certificate above.

Andrea McCarthy, Notary Public

ANDREA MCCARTHY
Notary Public - Notary Seal
STATE OF MISSOURI
St. Louis County
My Commission Expires: Jul. 30, 2027
Commission # 15636518

My Commission Expires: _____

Western Surety Company

POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT

Know All Men By These Presents, That WESTERN SURETY COMPANY, a South Dakota corporation, is a duly organized and existing corporation having its principal office in the City of Sioux Falls, and State of South Dakota, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

Dana A Johnessee, Donna Robson, Michael D Wiedemeier, Ashley Miller, Peter J Mohs, Andrea McCarthy, Andrew P Thome, Amanda L Williams, Christina A Culotta, Individually

of Chesterfield, MO, 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 it thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the corporation and all the acts of said Attorney, pursuant to the authority hereby given, are hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the Authorizing By-Laws and Resolutions printed at the bottom of this page, duly adopted, as indicated, by the shareholders of the corporation.

In Witness Whereof, WESTERN SURETY COMPANY has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 8th day of January, 2024.

WESTERN SURETY COMPANY

Larry Kasten, Vice President

State of South Dakota }
County of Minnehaha } ss

On this 8th day of January, 2024, before me personally came Larry Kasten, 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 WESTERN SURETY COMPANY described in and which executed the above instrument; that he knows the seal of said corporation; 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 corporation and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said corporation.

My commission expires
March 2, 2026

M. BENT
NOTARY PUBLIC
SOUTH DAKOTA

M. Bent, Notary Public

CERTIFICATE

I, L. Nelson, Assistant Secretary of WESTERN SURETY COMPANY do hereby certify that the Power of Attorney hereinabove set forth is still in force, and further certify that the By-Law and Resolutions of the corporation printed below this certificate are still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said corporation this day of , .

WESTERN SURETY COMPANY

L. Nelson, Assistant Secretary

Authorizing By-Laws and Resolutions

ADOPTED BY THE SHAREHOLDERS OF WESTERN SURETY COMPANY

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the shareholders of the Company.

Section 7. All bonds, policies, undertakings, Powers of Attorney, or other obligations of the corporation shall be executed in the corporate name of the Company by the President, Secretary, and Assistant Secretary, Treasurer, or any Vice President, or by such other officers as the Board of Directors may authorize. The President, any Vice President, Secretary, any Assistant Secretary, or the Treasurer may appoint Attorneys in Fact or agents who shall have authority to issue bonds, policies, or undertakings in the name of the Company. The corporate seal is not necessary for the validity of any bonds, policies, undertakings, Powers of Attorney or other obligations of the corporation. The signature of any such officer and the corporate seal may be printed by facsimile.

This Power of Attorney is signed by Larry Kasten, Vice President, who has been authorized pursuant to the above Bylaw to execute power of attorneys on behalf of Western Surety Company.

This Power of Attorney may be signed by digital signature and sealed by a digital or otherwise electronic-formatted corporate seal under and by the authority of the following Resolution adopted by the Board of Directors of the Company by unanimous written consent dated the 27th day of April, 2022:

"RESOLVED: That it is in the best interest of the Company to periodically ratify and confirm any corporate documents signed by digital signatures and to ratify and confirm the use of a digital or otherwise electronic-formatted corporate seal, each to be considered the act and deed of the Company."

Go to www.cnasurety.com > Owner / Obligee Services > Validate Bond Coverage, if you want to verify bond authenticity.

Exhibit I

PROJECT MANUAL

GARDI
CONCOURSE A SOUTHEAST
(Gates A40, A42, A44 & A46)

DEN Contract Number: 202474451

VOLUME I

DIVISION 01
GENERAL REQUIREMENTS

Issued for Construction
09 August 2024

City and County of Denver Department of Aviation

Philip A. Washington, CEO

SPECIFICATIONS TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

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 the currently approved DEN 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.

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. Material for work in the Terminal may be brought in through the Terminal Loading Dock accessed via Gate 1. Employee and material access to the Concourses will be via Gate 5.
6. The Contractor shall use the haul routes specified in the Construction Documents.
7. 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 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 AC150/5370-2C, "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:
   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.

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

SECTION 011420

SECURITY REQUIREMENTS & SENSITIVE SECURITY INFORMATION (SSI)

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 DESCRIPTION

A. Each Contractor is required to become a “Participant” in the DEN Airport Security Program (ASP), and must remain in good standing in order to retain Airport Security privileges.

B. All Contractor employees and all vehicles requiring access to the Secured Area, Sterile Area, and/or any other Controlled Areas shall be required to obtain the proper access authorizations for Airport ID badges and vehicle permits.

1.03 PARTICIPANT OF AIRPORT SECURITY PROGRAM

A. Contractors are required to become a “Participant" of the ASP. In order to become a “Participant”, your company must attend a Participant meeting within the Airport Security Office.

B. The Contractor shall comply with all Denver Municipal Airport System Rules and Regulations and all Transportation Security Administration (TSA) regulations. 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.

C. The TSA has the authority to issue civil penalties for failure to adhere to their regulations.

D. It is the responsibility of the Airport Security Office 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, at the Contractor’s expense, two (2) contract security guards at the gate that shall have been trained and certified by the Airport Operations Division to facilitate access to its Work. The Contractor assumes full responsibility for maintaining security once this is done. If the perimeter gate will be used as a haul route, the contractor must also place, at the Contractor’s expense, Haul Route Monitors as dictated by the TSA approved Temporary Amendment. Any fines levied against the Airport as a result of the failure by the Contractor to provide adequate security shall be passed on to the Contractor.

1. If the Contractor provides guards or monitors, the Contractor must also supply a shelter for the guards/monitors. The shelter must meet the following requirements:
    a. One 10 x 12 Tuff Shed or similar type structure with a window, 24-inch convex mirror mounted outside for vehicle inspection, sufficient HVAC capability, generator, light plant, and sanitary services, which are maintained by the Contractor.

E. Contractors will be required at all times to have a supervisor or foreman at each work

location in Secured, Sterile, and Controlled Areas.

F. All Work shall be accomplished in accordance with the most current FAA Advisory Circular (AC) 150/5370-2, "Operational Safety on Airports during Construction", 49 Code of Federal Regulations (CFR) Part 1542 and 14 CFR Part 139 except as modified herein.

G. All Work shall be accomplished in accordance with the most current TSA Security Directives applicable to DEN, except as modified herein.

H. This Section intends to supplement, modify, change, delete from, or add to the most current FAA AC150/5370-2. Where any paragraph, subparagraph, or clause of the AC is modified or deleted by these supplements, the unaltered provisions of that paragraph, subparagraph, or clause shall remain in effect.

1.04 SENSITIVE SECURITY INFORMATION (SSI)

A. If the Contract involves SSI information or procedures, the Contractor must contact the Assistant Director of Airport Security or designee, for disclosure information, as well as protocols that must be followed with SSI distribution.

B. This Section governs the maintenance, safeguarding, and disclosure of records and information that the TSA has determined to be SSI as defined by 49 CFR Part 1520, "Protection of Sensitive Security Information". SSI is information that the TSA has determined to be detrimental to the security of Denver International Airport if disclosed to unauthorized persons. This is a process for the documentation, use, and recovery of SSI of a specific origin.

C. Applicability:

1. For all management staff, all authorized departments, all contractors, and subcontractors handling documents or materials containing SSI information.

2. Each person employed by, contracted to, or acting on behalf of the Department of Aviation at Denver International Airport is subject to the requirements of this Section.

3. SSI disclosure is limited to persons or entities under criteria identified in federal regulations, subject to strict “need-to-know” standard, and as otherwise determined by TSA or the Department of Homeland Security (DHS).

D. Except as otherwise provided in this Section, records containing SSI are not available for public inspection or copying. Denver International Airport will not release such records to persons without a need to know. Prime contractors will not release SSI records to any subcontractor without a need to know. An employee or contractor has a “need to know” SSI if access to the information is necessary for performance of his or her official duties.

E. Unauthorized disclosure of SSI is a Federal violation of 49 CFR Part 1520 and violation is grounds for a civil penalty and other enforcement action by DHS Security. In addition to the civil penalties, corrective action may include issuance of an order requiring retrieval of SSI to remedy unauthorized disclosure, an order to cease future unauthorized disclosure, and dismissal from the work site.

F. Except as otherwise provided in writing by the TSA in the interest of public safety or airport security, the following information and records containing such information constitute SSI:

1. Information that would be detrimental to the security of Denver International Airport and aviation transportation.

2. Any performance specification, including a description of devices and procedures

used by Denver International Airport, for the detection of any weapon, explosive, incendiary, or destructive substance.

3. Any performance specification, including a description of devices and procedures, for any communications equipment used by Denver International Airport in carrying out any aviation transportation security requirements.

4. Details of any security inspection or investigation of an alleged violation of aviation transportation security requirements of Federal law that could reveal security vulnerability.

5. Specific details of aviation transportation security measures including those recommended by the Federal government.

6. The following information regarding security screening under aviation transportation security requirements of Federal law:
   a. Procedures for screening of persons, property, checked baggage, U.S. mail, and cargo.
   b. Information used by a passenger or property-screening program or system, including an automated screening system.
   c. Detailed information, if determined by the TSA to be SSI, about the locations at which particular screening methods or equipment are used.
   d. Performance or test data from security equipment or screening systems.

7. Identifying information of certain aviation transportation security personnel including lists of the names or other identifying information that identify persons as having unescorted access to a secure area of the airport.

8. Critical aviation asset information identifying systems so vital to the airport that the incapacity or destruction of such assets would have a debilitating impact on aviation security.

9. Any information involving the security of operational or administrative data systems identified by the Department of Transportation or DHS as critical to the safety or security of Denver International Airport.

10. Solicited or unsolicited proposals, pursuant to a grant or contract, to perform work that relates to security measures.

G. Restrictions on the Disclosure of SSI:

1. Employees and contractors working onsite have a duty to protect sensitive security information and must take reasonable steps to safeguard SSI in that person’s possession from unauthorized disclosure. When a person is not in physical possession of SSI, the person must store it in a secure container such as a locked desk, a locked file cabinet, or in a locked room. SSI is to be disclosed only to persons having a need to know as stated in CFR 1520. Requests for SSI are to be referred to City Project Manager.

2. Prior to receiving SSI records, contractors must sign the "Confidentiality and Non-Disclosure Agreement", Form PS-17, stating that SSI will be guarded from unauthorized persons, that records will be controlled while in use and secured when not in use, and that all SSI plans and records will be returned to the airport or destroyed following the completion of the Project.

3. Return or destruction of SSI documents must be done in a timely manner and documented on the SSI Return or Destruction Compliance Form, Form PS-20. Companies under contract to the City must return or destroy all SSI material following the completion of the Work. Companies not selected during the bidding process must return or destroy all SSI material immediately following the announcement of bid

results.

H. If a record containing SSI is received that is not marked as specified in this Section below, the following steps must be taken:

1. Mark the record as specified in paragraph Part 1 of this Section.

2. Inform the sender of the record that the record must be marked as specified in Part 1 of this Section.

I. If a person becomes aware that SSI has been released to unauthorized persons, promptly inform the Communication Center Supervisor at 303-342-4020 and request to speak to the on-call Airport Security Coordinator

J. Marking SSI:

1. In the case of paper records containing SSI, a covered person must mark the record by placing the PROTECTIVE MARKING conspicuously on the top, and the DISTRIBUTION LIMITATION STATEMENT on the bottom, of following parts of the document:
   a. The outside of any front and back cover, including a binder cover or folder, if the document has a front and back cover.
   b. Any title page
   c. Each page of the document

2. Protective Marking:
   a. SENSITIVE SECURITY INFORMATION
   b. Distribution Limitation Statement:
   c. WARNING: This record contains Sensitive Security Information that is controlled under 49 CFR parts 15 and 1520. No part of this record may be disclosed to persons without a “need to know”, as defined in 49 CFR parts 15 and 1520, except with the written permission of the Administrator of the Transportation Security Administration or the Secretary of Transportation. Unauthorized release may result in civil penalty or other action. For U.S. government agencies, public disclosure is governed by 5 U.S.C. 552 and 49 CFR parts 15 and 1520

3. In the case of non-paper records that contain SSI, including motion picture films, videotape recordings, audio recording, and electronic and magnetic records, a covered person must clearly and conspicuously mark the records with the protective marking and the distribution limitation statement such that the viewer or listener is reasonably likely to see or hear them when obtaining access to the contents of the record.

K. Destruction of SSI:

1. When the employee or contractor no longer needs the SSI to carry out their work requirements, the SSI must be returned to the issuing entity or completely destroyed by burning or cross-shredding to preclude recognition or reconstruction of the information.

2. The Contractor shall comply with all the requirements of the Department of Aviation Standards and Procedures, Protection of Sensitive Security Information (SSI) No. 10003 Revised 08/01/15 regarding Contractor Protection of Sensitive Security Information (SSI).

1.05 MISCELLANEOUS

A. Dumpster Security Requirements:

1. The following procedures must be followed to provide maximum security with all construction projects in public areas unless an exception has been made by the Airport Security Coordinator (ASC) or designee:
   a. Roll-off dumpsters must have the ability to be covered (hard side) and locked when not in use.
   b. When unlocked and in use, the Contractor shall provide an employee, or a subcontractor's employee, to stand by the dumpster to prevent unauthorized placement of prohibited items
2. If the Contractor is not able to have a roll-off dumpster with the ability to be locked, the dumpster shall be removed from the public area when the construction site is inactive.

B. Contractor Fences (Not Perimeter Fence):

1. If required, the Contractor shall establish and maintain a secure (fenced) perimeter at its primary operations area to include its field offices, staging and storage areas, and maintenance facilities. The responsibility for security within its operations area shall rest solely with the Contractor. Entrance gates to operations areas shall be equipped with a combination of locks to include a lock provided by the City for its use in accessing emergency equipment, should that need arise. The location, size and other physical characteristics of the Contractor's operations area must be approved by the DEN Project Manager prior to its installation.
2. Unless specifically required by the Contract Documents and with the exception of the fenced operations area described above, the Contractor shall install no fences or other physical obstructions on or around the Project work area without the written approval of the DEN Project Manager.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SUBMITTAL FOR AIRPORT ID BADGES

A. By submitting information for the individual requesting or requiring an Airport ID badge that would permit unescorted access to the Sterile and/or Secured Areas must be fingerprinted and pass a Criminal History Records Check (CHRC) and Security Threat Assessment (STA). Passing a CHRC means the employee shall not have been convicted, given a deferred sentence, found not guilty by reason of insanity or have been arrested and are awaiting judicial proceedings of any felony charge during the ten (10) years before the date of the individual's application for unescorted access authority. For an individual to obtain driver authorization to drive within the Secured Area, the individual must have a valid driver license that allows them to drive their contractor vehicle.

B. An employee requesting an Airport ID badge must resolve all pending or valid violations before being allowed to proceed in the airport ID badging process. If the employee no longer works for the company and is attempting to be employed by a different company, a management representative from the "new" company must attend the Violation Notice Hearing along with the employee.

C. Airport ID Badges are obtained as follows:

1. The Contractor shall meet with the City Project Manager to review the procedures and required access points at DEN. The Contractor and the DEN Project Manager shall visit the site to verify the access points. Access points shall be listed and submitted by

the Contractor to the DEN Project Manager for review and comment prior to Contractor's application for badging.

2. The Contractor shall designate an Authorized Signatory who must attend an annual class with Airport Security. The Authorized Signatory must be an employee of the Contractor, have a valid Denver International Airport ID badge. The Authorized Signatory will be authorized to sign for the Contractor on the Fingerprinting and Badge Application Form and will be the primary designation contact for Airport Security related business.

3. The Contractor's Authorized Signatory shall schedule a Participant Meeting with the DEN Airport Security Office to review DEN security procedures and receive training on how to ensure that all Participants remain in compliance with Part 20 of the Denver Municipal Airport System Rules and Regulations. A second meeting will be scheduled for the Authorized Signatory to learn how to successfully complete the required forms for Airport ID badges and vehicle permits.

4. A CHRC and STA are required for each employee requesting unescorted access to the Secure and/or Sterile Area. The employee will complete the Fingerprinting and Badge Application (two-sided form) and schedule an appointment with the Airport Security Office to have the form reviewed and to be fingerprinted. The Federal Bureau of Investigation will conduct the CHRC and will return the results to the Airport Security Office. For the fee for the Fingerprinting, please see the flydenver.com website. The Transportation Security Administration will process the STA and will return the results to the Airport Security Office.

5. When the Authorized Signatory is notified by Airport Security that the CHRC and STA have cleared, the applicants must come to the Airport Security Office to receive regulated security and driver training. The training will take approximately one (1) hour for security training and approximately two (2) hours for security and driver training.

6. All applicants must watch and pass all concepts of a computer based security training module for a Security Identification Display Area (SIDA) Airport ID badge. All individuals requesting driver authorization in the non-movement area must also view an interactive computer based driver training module and complete a test by passing all concepts. In addition, the individual must receive non-movement driver orientation training by the Contractor's driver representative before being allowed to drive on the airfield. Non Movement Orientation training should be conducted annually.

7. All Airport ID badges must be immediately terminated upon employee separation from the Contractor or when a need for DEN access no longer exists.

8. The Airport ID badges must be returned to the Airport Security Office prior to final payment. All Airport ID badges are issued with an annual expiration date. The expiration date is determined by the birthday of the Airport ID badge holder. Contractors shall notify the DEN Project Manager as soon as possible but in no case less than four (4) weeks in advance of any requirement to extend the Sponsorship status.

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 011420

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:

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

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. Century Link Telephone
2. DEN Telephone
3. Xcel Energy Natural Gas
4. Xcel Energy Elec. Services
5. DEN Storm Water
6. DEN Sanitary Sewer
7. DEN Deicing Waste
8. Denver Water Department
9. DEN Deicing Supply operated by Inland Technologies
10. Fuel System (ASI)
11. Premise Wiring System- DEN Business Technologies
12. FAA Duct Bank
13. Oil/Gas Wells
14. DEN Electrical Department
15. Fire Alarm System
16. Paging System

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. Section 312323.33 "Flowable Backfill (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 Section 312323.33 "Flowable Backfill (Controlled Low-Strength Material)" and Division 26 and Division 33 requirements.

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

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.

3.04

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 012510

SECTION 012600

CONTRACT MODIFICATION PROCEDURES

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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CHANGE MANAGEMENT PROCEDURES

A. General Process Requirements

1. Refer to Project Management for Software Requirements Section 013100 Project Management and Coordination.
2. Refer to the City and County of Denver Standard Specifications for Construction General Contract Conditions Title 11 requirements
3. Process
    a. Change Mechanism Types
        1) Change Directive
            a) DEN directed change/scope changes that are necessary for safety or operations – scope addition is not optional. DEN provides a budget via CD, and the contractor responds via CDR with costs (either actual or negotiated). Once the CDR is approved, a change order may be issued for the difference between the CD and the CDR.
        2) Change Notice
            a) When to use: DEN directed changes/scope for which the contractor can propose costs to do the work. A CN does not mean the work will take place; project impacts, including cost and schedule, must be negotiated and agreed upon before the work takes place. Once the change notice is negotiated, a change order may be issued.
        3) Contractor Change Request
            a) Adverse or changed conditions encountered by the contractor that were not the result of DEN direction; RFI responses that differ from spec that may result in additional cost or schedule. Once the CCR is approved, a change order may be created.
    b. Non-Standard Contract Changes
        1) Suspension
            a) Suspensions should be recorded through a change notice. The contractor may respond with any associated costs.
        2) Termination
            a) Terminations should be recorded through a change notice. The contractor may respond with any associated costs.
        3) Minor Contract Language Change
            a) Changes to contract language should be recorded through a change notice. In addition to the normal Unifier approval process, Airport Legal

Services (ALS) should also review and approve of changes in the contract. Common situations where this may occur:
(1) Project Milestone Changes
(2) Submittal Requirements
(3) Insurance Requirements
(4) Other
(5) Other

4) Specification Change
a) Changes to spec should be recorded through an RFI if possible. If not, then a CN may be issued for spec changes. In addition to the normal Unifier approval process, the spec owner/SME should review and approve of the change.

5) Major Contract Language Change
a) Major Contract Language Changes require the involvement of Airport Legal Services (ALS) and may require additional approval, up to and including City Council. Situations where this may be necessary would include
(1) Removal of special conditions, exhibits, or attachments to the contract
(2) Increase in contract capacity over a designated value
(3) Any other contract change that has not been covered by this section.

c. Change orders
1) Change Directives, Change Notices and Contractor Change Requests will be executed and incorporated into a contract via a Change order only.

B. Submission Requirements

1. Refer to Section 013100 Project Management and Coordination.

3.02 TIMELINE

A. The Contract General Conditions (Standard Specifications for Construction General Contract Conditions) Title 11 provides timelines and deadlines for approval. The contractor shall refer to this section of the contract for specific requirements, in addition to any special conditions within the contract.

B. The deadlines specified in Title 11 should be applied to the initial submission package for a change. Any requests for revision, including negotiations, will be subject to the following deadlines.

1. If a contractor is asked to revise a final proposal, the revision will be completed and submitted through the designated system within seven (7) calendar days.

2. DEN will have fourteen (14) calendar days to review any revised proposal and provide a recommendation back to the contractor. This includes any reviews of the proposal on behalf of DEN, including third parties, subject matter experts, and Project Manager reviews.

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 012600

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.

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

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 012976

PROGRESS PAYMENT PROCEDURES

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 SUMMARY

A. Section includes requirements for the following:

1. Section 011100 “Summary of Work”
2. Section 013100 “Project Management and Coordination”
3. Section 013300 “Submittal Procedures”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. General Process Requirements

1. Payment application need to be submitted as per the Agreement.
2. Comply with the PM Guide for invoicing.

B. Progress Payment Package

1. Subcontractor Payment Verification
   a. The Contractor shall submit with the Schedule, a report of all work performed by subcontracted parties of all tiers, and current payment status.
   b. The report shall include the following minimum fields:
      1) Project name
      2) Project number
      3) Date
      4) Name of Contractor
      5) Name of all subcontractors, of all tiers, as listed in the bid as well as any subsequently submitted CM-02 forms, including the following information for each subcontracted firm:
         a) Total value of work performed
         b) Total amount paid to date
         c) Date of last payment
         d) Balance due
         e) Payment Terms
         f) Remaining balance to be paid
         g) Planned payment date
   c. Failure to provide this information may result in withholding of progress payments, pursuant to Article 909.1 of the General Contract Conditions

C. Submission Requirements

1. Refer to the PM Guide for invoicing.

3.02 TIMELINE

A. Prompt Pay Requirements

1. Refer to the Prompt Pay Ordinance

B. Penalties for Late Payments

1. A Key Performance Indicator (KPI) is a way of measuring specific performance of the Contractor for which a target is stated in the KPI Schedule contained in Exhibit / Table (X). The KPIs for this section relate to the Contractor's performance with submitting documentation related to invoice submissions and proof of subcontractor / vendor payment, see Exhibit / Table (X).
2. An assessment of the Contractor’s performance against the KPIs is made monthly at the time of the Contractor's invoice submittal and request for payment. Reporting of performance and assessments are carried out in accordance with the provisions of this Article.
3. As used in this clause and specification, the Moderated Amount represents the amount of Contractor’s fee contained in each payment application.
4. If the Contractor achieves a target stated for a Key Performance Indicator in respect of any assessment interval, they are entitled to be paid the allocated weighting set out in the KPI Schedule of the Moderated Amount, in respect of that monthly assessment interval ("Due Moderated Amount").
5. The Moderated Amount and each Due Moderated Amount in respect of the first two assessment intervals following the Contract Date shall be paid as submitted and reviewed in order to allow the Contractor to become acquainted with the invoice submission process.
6. Where the Contractor does not become entitled to be paid Due Moderated Amounts which in total equal the full amount of the Moderated Amount in respect of the relevant assessment interval, the Contractor still has the opportunity to earn the amount of the Moderated Amount to which they did not become entitled in respect of the relevant assessment interval (the "Shortfall"). The Contractor is entitled to be paid the proportion of the Shortfall relating to a particular target in respect of an assessment interval for a KPI if and when the Contractor achieves that target for the three consecutive assessment intervals immediately following the assessment interval in which the Shortfall occurred. If, a particular KPI ceases to be measured and there is fewer than three assessment intervals between a Shortfall arising as a result of the failure to meet the target for that Key Performance Indicator and the date on which it ceases to be measured, then the Contractor loses the opportunity to earn back the Shortfall.
7. If the Contractor's obligation to perform is terminated for any reason, the Contractor is only entitled to be paid any amounts which had become due under the foregoing provisions of this clause prior to the date of termination.
8. If there ceases to be five Key Performance Indicators, the percentage weighting in respect of each KPI shall be adjusted at the discretion of DEN.
9. DEN may during each third assessment interval review the KPI regime described in this clause and in the KPI Schedule and, following such review, DEN may with the Contractor's agreement (not to be unreasonably withheld) amend any aspect of the KPI regime described in this clause and in the KPI Schedule. Should the Contractor withhold its agreement unreasonably it shall lose the opportunity to earn back any Shortfall.

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 012976

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

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:

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 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.

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 BPXP.

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 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.
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 will facilitate a response to the contractor within fourteen (14) calendar days of receipt, regardless of whether the RFI is an original or re-submission, either through the PMIS or, if the PMIS is not used, via email. This response time will include any reviews from a third party, including DOR/EOR, Architects, Commissioning Agents, or other SMEs.
3. DEN Project Manager’s response may include a request for additional information or revision and resubmittal of the RFI. Contractor shall clearly reference the previous RFI on the new submittal record.
4. 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.
5. 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.
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 011420 "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

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.

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.

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;

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	☐	☐	☐	Did Contractor meet with DEN PM obtain the data standards and general requirements for data gathering?
2	☐	☐	☐	Did Contractor meet with Airport Survey Office to obtain airport survey control points, projection parameters, and airport survey training materials?
3	☐	☐	☐	Did Contractor provide Survey Statement of Work to DEN PM?

4	☐	☐	☐	Did Contractor provide Geodetic Verification Survey to DEN PM?
5	☐	☐	☐	Did Contractor provide Survey Control Plan to DEN PM?
6	☐	☐	☐	Did Contractor provide Imagery Plan to DEN PM? (Only required if collecting aerial imagery)?
7	☐	☐	☐	Did the FAA accept survey plans?
	Yes	No	N/A	Construction Phase (As-Builts)
8	☐	☐	☐	Did Contractor perform field survey of project site to collect accurate as-built data?
9	☐	☐	☐	Did the Contractor provide DEN PM with subsurface utility data?
10	☐	☐	☐	Each week, did the Contractor provide DEN PM with Project Status Reports?
11	☐	☐	☐	Did the Contractor provide DEN PM with 25% as-built data in both CADD and GIS formats including all attribute information and metadata?
12a	☐	☐	☐	Did DEN PM report 25% QA findings via email to Contractor?
12b	☐	☐	☐	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	☐	☐	☐	If applicable, did DEN PM report 50% QA findings via email to Contractor?
12d	☐	☐	☐	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	☐	☐	☐	If applicable, did DEN PM report 75% QA findings via email to Contractor?
13	☐	☐	☐	Did the Contractor provide DEN PM with 100% as-built data in both CADD and GIS formats including all attribute information and metadata?
14	☐	☐	☐	Did Contractor provide DEN PM with a completed Final Survey Report?
15	☐	☐	☐	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

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. Construction surveying shall be measured as lump sum. There shall be no separate measurement for work associated with construction surveying. This item shall include all materials and labor required to complete the work.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Construction surveying payment will be made at the contract unit price per lump sum for the work completed. This price will be full compensation for furnishing all materials, all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

013223.11-1 Construction Surveying – per lump sum

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 lied 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 (±3) cm; the difference in ellipsoidal height must agree within, plus or minus, four (±4) cm, and the difference in orthometric height must agree within, plus or minus, five (±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:

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

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.

B. Related Sections:

1. 012600 - Contract Modification Procedures

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.

A. For large files that cannot be uploaded through Unifier, contact Project Manager.

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.

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.

D. Allow a minimum cycle of 30 days for review of each submittal by the DEN Project Manager.

E. Submittal 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

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.

3.04 MONETARY PENALTIES FOR LATE SUBMITTALS

A. A Key Performance Indicator (KPI) is a way of measuring specific performance of the Contractor for which a target is stated in the KPI Schedule contained in Exhibit / Table (X). The KPIs for this section relate to the Contractor's performance with submitting documentation related to invoice submissions and proof of subcontractor / vendor payment, see Exhibit / Table (X).

B. An assessment of the Contractor’s performance against the KPIs is made monthly at the time of the Contractor's invoice submittal and request for payment. Reporting of performance and assessments are carried out in accordance with the provisions of this Article.

C. As used in this clause and specification, the Moderated Amount represents the amount of Contractor’s fee contained in each payment application.

D. If the Contractor achieves a target stated for a Key Performance Indicator in respect of any assessment interval, they are entitled to be paid the allocated weighting set out in the KPI Schedule of the Moderated Amount, in respect of that monthly assessment interval ("Due Moderated Amount").

E. The Moderated Amount and each Due Moderated Amount in respect of the first two assessment intervals following the Contract Date shall be paid as submitted and reviewed in order to allow the Contractor to become acquainted with the invoice submission process.

F. Where the Contractor does not become entitled to be paid Due Moderated Amounts which in total equal the full amount of the Moderated Amount in respect of the relevant assessment interval, the Contractor still has the opportunity to earn the amount of the Moderated Amount to which they did not become entitled in respect of the relevant assessment interval (the "Shortfall"). The Contractor is entitled to be paid the proportion of the Shortfall relating to a particular target in respect of an assessment interval for a KPI if and when the Contractor achieves that target for the three consecutive assessment intervals immediately following the assessment interval in which the Shortfall occurred. If, a particular KPI ceases to be measured and there is fewer than three assessment intervals between a Shortfall arising as a result of the failure to meet the target for that Key

Performance Indicator and the date on which it ceases to be measured, then the Contractor loses the opportunity to earn back the Shortfall.

G. If the Contractor's obligation to perform is terminated for any reason, the Contractor is only entitled to be paid any amounts which had become due under the foregoing provisions of this clause prior to the date of termination.

H. If there ceases to be five Key Performance Indicators, the percentage weighting in respect of each KPI shall be adjusted at the discretion of DEN.

I. DEN may during each third assessment interval review the KPI regime described in this clause and in the KPI Schedule and, following such review, DEN may with the Contractor's agreement (not to be unreasonably withheld) amend any aspect of the KPI regime described in this clause and in the KPI Schedule (Exhibit / Table (X)). Should the Contractor withhold its agreement unreasonably it shall lose the opportunity to earn back any Shortfall.

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

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

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.

PART 2 - PRODUCTS

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.
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

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 011420 "Security Requirements and Sensitive Security Information".
2. Section 011430 "Vehicle and Equipment Permitting".
3. 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

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.

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.

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.

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

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

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] <Insert item of concern>. 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: DEN Project Manager will 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 monthly 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 measured drawings, preconstruction photographs and preconstruction videotapes.

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 applicable items 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. Obtain City's approval for operations involving use of open-flame or welding or other high-heat equipment. Use of open-flame equipment is not permitted. Notify DEN Project Manager at least 72 hours before each occurrence, indicating location of such work.

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 2 hours 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.

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

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. Section 015719 "Temporary Environmental Controls" for environmental and related permitting requirements.

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

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

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.

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

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:

Abbreviation	Definition
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

Abbreviation	Definition
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

Abbreviation	Definition
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

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.

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. ASTMA 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.

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

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)

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

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.

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

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.

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 014510

CONTRACTOR QUALITY 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. This Section identifies the Quality Control activities to be performed during all phases of the Contract by the Contractor.

B. The Contractor shall have in place a Quality Control Program as necessary to ensure that all materials and work are completed in compliance with Contract Documents. The Contractor is solely responsible for Quality Control and shall provide the necessary quality control personnel to ensure that all materials, workmanship, and tests are in conformance with the Project documents with the exception of those tests and/or audits that may be conducted by the City as defined in the contract documents.

C. Test schedules and/or testing requirements for materials used on this project are included in the technical specifications. Laboratory and field-testing identified in the specifications shall be conducted by a Testing Agency retained by the Contractor; hereafter is referred to as the Contractor Testing Agency (CTA).

D. The City or the City's consultant will employ a testing agency to perform all the required Quality Assurance and Special Inspection Testing of material and Inspection of workmanship required by the Contract Documents and the Building Official to fulfill the code and the regulatory authority's requirements. The Contractor must schedule these tests and provide access to the City inspectors and testers to perform these tests and inspections on behalf of the City. The performance of the tests by the City does not relieve the Contractor of the responsibility to deliver a fully functional building meeting all the requirements of the Contract Documents and their intent. The Contractor must develop its own testing program for processing, acceptance from the subcontractor or suppliers at a frequency defined by the contractor for its own process control and to assure delivery of the intended acceptable workmanship. All time impacts of testing and retesting shall be accounted for in the updated schedule and any mitigation of time impacts shall be the responsibility of the Contractor.

1.03 SUBMITTALS

A. Refer to Section 013300 "Submittals" and Section 013325 "Submittal Procedures" for submittal requirements.

B. Quality Control Plan: Within ten (10) days after Notice to Proceed, the Contractor shall submit a Quality Control Plan for review and acceptance. The Quality Control Plan shall be accepted by the DEN Project Manager prior to any Work or materials being incorporated into the Project. Acceptance by the DEN Project Manager does not relieve the Contractor of its responsibility to comply with the Contract Requirements. The Contractor Quality Control Plan shall address the following as a minimum:

1. A general description of Quality Control monitoring to be performed until final acceptance by DEN. Include monitoring activities of Work and the work site during

times that no construction activity is scheduled to take place.

a. No work requiring QC inspection and testing shall take place without QC inspection and testing staff on site.

2. An individual designated by the Contractor and approved in writing by the DEN Project Manager whose [sole] responsibility is Quality Control Management. This individual shall be highly qualified in all phases of construction as it relates to this Project and shall have the authority to direct work changes required to bring the Work into conformance with Contract requirements, including stopping non-conforming work in progress. A detailed resume of the proposed Quality Control Manager including applicable education, experience, and certifications shall be included in the Quality Control Plan.

   a. At the discretion of the DEN Project Manager, for Small Projects, Early Work Packages and Task Orders all of value less than $1,000,000 or a duration which is less than three (3) months, the Contractor may assign one of the Contractor's staff, i.e. Contractor's Superintendent, Office Engineer, Field Engineer, or Contractor's Project Manager as Quality Control Manager. The assigned person must be on site while work requiring QC inspection and testing is being completed and available to discuss quality issues, manage all aspects of the Project Quality Control Plan, coordinate all required Special Inspection and Quality Assurance testing, and provide proposed solutions on all quality issues at any time as to not cause any delay to the project. Any delays caused in part or in all due to defective or no conforming work shall be borne by the Contractor.

3. Quality Control inspection staff as needed to assist the Quality Control Manager with implementation of the Quality Control Program. Duties of the Quality Control Inspectors shall be limited strictly to inspection of the ongoing work. Sampling and testing of materials shall be performed by Quality Control personnel other than Quality Control Inspectors. Quality Control Inspectors shall inspect only those work elements for which they are qualified. Resumes of the proposed Quality Control Inspectors including applicable education, experience and certifications shall be included in the Quality Control Plan.

4. An Organization Chart identifying all Quality Control staff by name and function. The chart shall indicate the total staff required to implement all elements of the Quality Control Program, including inspection and testing for each item of work including tests performed by the CTA or DTA. If necessary, different Quality Control staff can be utilized for specific inspection and testing functions for different items of work. The chart shall show that the Quality Control Manager, Quality Control Inspectors, and Quality Control testing personnel are outside of the production staff with clear lines of authority for Quality Control.

5. The City will employ a DTA. If the Project Management Team for the project is a consultant of the City, then the City's consultant may employ a DTA. The Contractor's testing and inspection shall be performed for the processing, preparation and to request City's inspection and as necessary to produce the required product as specified in the Contract Documents. The Contractor shall meet the minimum inspection and testing frequencies specified in the contract documents. When the contract documents do not specify minimum inspection and testing frequencies the Contractor shall propose in writing to the DEN Project Manager a QC inspection and testing frequencies that meet or exceed industry standards for the material and work being placed or conducted.

6. Any test performed by any agency on the Project shall be recorded and show a passing re-test of all failing tests.

   a. All test results shall be made available for inspection by the DEN Project Manager. This includes tests that are above the QC testing frequency required.

7. Any tests submitted by the Contractor for basis of acceptance, or payment reduction

when performed by the Contractor or on its behalf, must meet all standards and must be certified to have followed approved procedure, processed in a certified lab by properly certified or licensed personnel by properly certified testers and on calibrated and certified equipment. Authentications of tests must be preapproved and cannot be selectively submitted. All tests shall be recorded in the field witnessed by DEN's inspector in order to be accepted as a record test of the material in question. Any failing tests could be the sole basis for rejecting the material.

8. Each technical specification division's requirements for quality control identifying each item requiring submittal and approval/acceptance prior to installation of work, all inspections to be performed during work and prior to acceptance of work, each item of work requiring testing by the independent testing agency or the City provided testing agency, and the testing frequency.

9. The plan shall address all elements of special inspection required by the statement of special inspection as approved by the Building Official. All special inspections and tests will be performed by agencies employed by the City.

10. The Contractor is responsible for the complete record of inspection file including but not limited to all manufacturer certificates, certificates of material compliance, Certificates of Material Testing Record, successful re-inspection of all deficiency items, proper deposition of design related Non-Conformance reports (NCR), Structural Engineers' observation reports, certification letters from the DTA, Building Inspectors' records of approvals, permit cards, fire suppression and fire- alarm tests records as witnessed by the authorities of jurisdiction and any record necessary to achieve a certificate of occupancy.

11. The Contractor must keep track of all logs of discrepancies and submit periodic updates, as required by the DEN Project Manager, of all open issues and track the closure of open items in a timely manner.

12. Establish controls and documentation format to ensure that items or materials that have been accepted through receiving inspection are used or installed. Identification and traceability shall be provided throughout all inspections, test activities, and records. For stored items, provisions shall be made for the control of item/material identification, consistent with the expected duration and type of storage.

13. A methodology of monitoring, testing, and exercising of all equipment, valves, and/or assemblies to ensure the Work installed is in proper working order.

14. A list of suppliers and subcontractors. This 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 resubmitted as required.

15. All approvals related to Special Inspection are subject to the acceptance or approval of the Building Official.

16. Emergency contact information including name, company, title, work phone number, home phone number, and other means of contact. The Emergency Contact list shall include at least four individuals. The Emergency Contact list shall be maintained on a daily basis. In the event there is any change in any of the information, the Contractor shall forward the updated list to the DEN Project Manager and to DEN Maintenance Control (303-342-2800). The Emergency Contact list shall include the project number, project title, and date of issue.

C. The Contractor shall transmit the following daily reports to the DEN Project Manager electronically PRIOR TO THE CLOSE OF BUSINESS ON the following workday:

1. CM-13 Contractors Daily Construction Report. The Foreman may add sheets of information to this form as needed.

2. CM-07 Daily Quality Control Inspection Report and all CTA test results performed that

day.

3. CM-08 Daily DEN Time and Materials Report

D. Deficiency List: The Quality Control Manager shall establish a deficiency list including the minimum information for each deficiency item; description, date, location, drawings reference, detail reference, specification reference, and superseding document NCR, date of expected solution date repaired date inspected by City representative and accepted.

1.04 DOCUMENTATION

A. The Contractor shall not change or alter approved submittals, procedures, specifications, drawings/MODELS, or other pertinent documentation without the DEN Project Manager's written authorization.

B. All records and documents that are related to quality control or assurance shall be prepared, identified and maintained by the Contractor and shall be made available to DEN upon request. Records shall be protected from damage, deterioration, or loss. A copy of the records and documents shall be maintained at the Work site at all times unless the DEN Project Manager has approved other locations in writing. Retention time for all quality records shall be not less than six (6) years from date of Final Acceptance of the Contract.

C. The Contractor is responsible for the complete record of inspection file including but not limited to all manufacturer certificates, certificates of material compliance, Certificates of Material Testing Record, successful re-inspection of all deficiency items, proper deposition of design related NCRs, Structural Engineers' observation reports, certification letters from the DTAs, Building Inspectors' records of approvals, permit cards, fire suppression and fire-alarm tests records as witnessed by the authorities of jurisdiction and any record necessary to achieve a Certificate of Occupancy.

D. The Contractor shall maintain records at the actual worksite and at Contractor's office to show the inspection status of materials and items installed in order to ensure that the required inspections and tests have been performed in a timely and correct manner.

E. The Contractor must keep a record of all deficiency issues and show positive evidence of closure (passing re-inspection or re-test) to every issue.

1.05 INSPECTIONS AND TESTS

A. Inspections, tests and system shut down requests, conducted by persons or agencies other than the Contractor, shall not in any way relieve the Contractor of the responsibility and obligation to meet all specifications and the referenced standards. The Contractor's designated Quality Control Representative shall inspect the work and shall ensure the Work complies with the Contract requirements prior to any requests for inspection or testing.

B. When the specifications, laws, ordinances, rules, regulations or orders of any public agency having jurisdiction require the DEN Project Manager's surveillance of inspections or tests, the Contractor shall notify the DEN Project Manager, in writing, of the place, date and time 48 hours prior to the inspection and/or test. The Contractor shall be responsible for notifying and requesting inspection by other agencies including but not limited to the Denver Building Inspection Division, Denver Fire Department, and Denver Water Department. Prior to request for other agency inspections, the Contractor shall meet and plan inspection times with the DEN Project Manager.

C. Special inspections or tests may be required by the technical specifications, City, State and/or Federal Agencies in addition to those tests already performed. The Contractor shall notify the DEN Project Manager, in writing, at least 48 hours in advance of the additional

inspections or tests.

D. Quantities will be verified as defined in the Pre-Work Meetings.

1.06 INSPECTION PLAN

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 Drawings and specifications, the referenced codes and standards and the approved submittals:

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 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 will be held with the Contractor's superintendent, Quality Control and Safety representatives, and DEN Project Manager. Supervisory, Safety and Quality Control, representatives of all applicable subcontractors will also attend. Prior to the meeting, the Contractor's Quality Control Manager shall provide the DEN Project Manager with a meeting agenda for review. The Contractor's Quality Control Manager shall conduct the meeting and distribute the approved agenda. The Quality Control Manager shall develop and electronically distribute finalized meeting minutes within one business day upon completion of the meeting. The following items shall be presented and reviewed by the Contractor:
   a. Contract requirements and specifications.
   b. Shop drawings, certifications, submittals, models, and as-built drawings.
   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, security, 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.
2. Initial Inspection: Upon completion of a representative sample of a given feature of the Work and no later than two weeks after the start of a new or changed operation, the DEN Project Manager and/or the DEN Project Manager's designated representatives 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 Drawings, specifications 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/MODELS 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.

3. 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.

4. 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 shall notify the DEN Project Manager, in writing, 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.

5. 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 and when 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 because of the incompleteness of the Work.

6. The DEN Project Manager will schedule the Pre-Final Acceptance Inspection and will prepare a list of deficient items (punch list) 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 by the DEN Project Manager. 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 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.

1.07 CONTRACTOR SUBMITTAL OF PROPOSED CONTRACTOR'S TESTING AGENCIES

A. Refer to Section 014525 - Material Testing Agency

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 REQUIREMENTS

A. All materials required for the Contract shall be new except where specified otherwise. The DEN Project Manager may elect to perform additional inspections and/or tests at the place

of the manufacture, the shipping point or at the destination to verify conformance to applicable specifications. Inspections and tests performed by DEN shall not relieve the Contractor from the responsibility to meet the specifications, nor shall such inspections/tests be considered a guarantee for acceptance of materials that will be delivered at a later time.

B. Materials accepted based on a Certificate of Compliance may be sampled and inspected/tested by DEN or its designer at any time. The fact that the materials were accepted based on such certification shall not relieve the Contractor of the responsibility to use materials that conform to the specifications.

C. The Contractor shall impose upon suppliers the same quality control requirements, including inspection and test procedures, as imposed upon him by the specifications and referenced standards. The Contractor shall apply appropriate controls, designed to ensure that all materials supplied meet the requirements and specifications.

3.02 NONCONFORMING WORK AND MATERIALS

A. Non-conformance Report (NCR)

1. The Project Manager will issue an NCR to the Contractor whenever there are violations of the terms of the contract that cannot be immediately brought back into conformance, including materials received and/or items of the work found not to be in conformance with contract requirements. When issued, a Non-conformance Report will prelude payment for elements noted and will remain in effect until corrective actions have been submitted, approved, and performed.
2. The NCR will describe the nature and extent of nonconforming elements and will include space for the Contractor’s corrective action proposal, the designer’s review of the Contractor’s proposal, reinspection and/or verification of approved corrective rework and a space for the Project Manager’s disposition of the nonconformance matter. Copies of the NCR, at each step of its processing (i.e., initial issuance to Contractor through final disposition), will be sent to the Contractor.
3. The NCR will be signed by the DEN Project Manager, and Contractor must acknowledge and sign the NCR within (10) days.
4. The Project Manager will make the disposition of nonconforming items/materials.
5. Failure to list any nonconforming work on an NCR does not relieve the contractor of responsibility for completing the Work in accordance with all contract requirements.
6. The contractor cannot submit change requests associated with any portion of work under an NCR.

B. The Contractor is obligated to correct any item deem deficient.

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 014510

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

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:

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

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

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.

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.

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:

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

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 Phasing and Barricade Layout Plan prior to construction start.

C. 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.

B. The Contractor will be required to mobilize multiple times throughout the duration of the project per the plans. The Contractor shall submit a phasing and barricade layout plan per the construction plans and specifications. The plan shall be approved by DEN Project Manager prior to the start of the project.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Mobilization shall be measured as lump sum per phase. There shall be no separate measurement for work associated with these items. Coordination with DEN Operations and DEN Stakeholders shall be incidental to the work. Barricade movement within the overall project site limits shall be incidental to the work, no additional payment will be made.

B. Refer to Section 013210 – SCHEDULE, for detail regarding mobilization scheduling, billing, and payment.

C. Textura Fee shall be measured as lump sum.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment will be made at the contract unit price per lump sum for the work completed. This price will be full compensation for furnishing all materials, all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

015050-1 Mobilization – per lump sum

015050-2 Textura Fee – per lump sum

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.
2. Section 312319 "Dewatering" for disposal of ground water at Project site.
3. Section 321216 "Asphalt Paving" for construction and maintenance of asphalt pavement for temporary roads and paved areas.
4. Section 321313 "Concrete Paving" for construction and maintenance of cement concrete pavement for temporary roads and paved areas.

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.
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).
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

SECTION 015525

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 within 24 hours, and provide flaggers or other mitigation as required to maintain safe traffic control until devices have been replaced.

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 TRUCK BOSS

A. Furnish a "Truck Boss" during hauling operations along Oak Hill Street during all hauling operations to and from the Contractor's staging area, recycle yard, and borrow area. The truck boss will be responsible for the haul truck caravans and ensuring safe crossings of the active taxiways. All hauling operations shall include a truck boss and a sweeper as part of the work. This work shall be considered incidental to Traffic Control.

3.05 CONSTRUCTION VEHICULAR TRAFFIC

A. Restrict construction vehicles to approved haul routes.

B. Any contractor requests for revisions or modifications to the approved airfield haul routes in the contract documents, or for airfield haul routes not otherwise depicted in the contract documents, must follow the change management process.

3.06 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.

3.07 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. Furnish and install all signage for access and egress from the building during construction as required in the permit set. A permit set shall be requested from DEN PMT. Each access/egress signage assembly will consist of two signs to be temporarily mounted on the pedestrian doors, and an orange warning cone to be placed inside the building directly in front of the door.

E. Authorize, modify, and install regulatory parking controls and vehicle turn restrictions.

F. Implement those traffic control modifications outside of the traffic control zone that are necessary to manage diverted traffic.

G. 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 City and County of Denver) and removal upon completion; of the low profile barricades (with lights), temporary jersey barriers with fencing and mesh, temporary haul routes, truck boss, , detour signage, temporary signage, temporary pavement markings, gates, and any other item associated with providing traffic control for the project.

B. Measurement for gate guard shall be made per hour. This shall include all associated costs with providing the gate guards.

C. Measurement for gate guard shack shall be made per lump sum to include furnishing the shack, desk, chair, portable generator, light plant, adequate hvac, interior/exterior lighting, portable sanitation and pole mounted convex mirror, including removal upon completion.

D. Measurement for Access/Egress Signage Assembly shall be made per each to include furnishing, installation, maintenance, and removal of all materials necessary to complete the work.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for traffic control will be made at the contract unit price per lump sum. This price will be full compensation for procurement, installation, maintenance, re-positioning between phases (as required by phase or City and County of Denver) and removal of low profile barricades, temporary jersey barriers with fencing and mesh, temporary haul route, truck boss, detour signage, temporary signage, temporary pavement markings, gates, and any other item associated with traffic control, as required to complete the item. This includes all labor, equipment, tools and incidentals necessary to complete the item.

B. Payment for gate guard will be made at the contract unit price per hour.

C. Payment for gate guard shack will be made at the contract unit price per lump sum. This price shall be full compensation for furnishing all materials and for all preparation, installation, maintenance, utilities and removal as required to complete the item; and for all labor, equipment, tools, and incidentals necessary to complete the item.

D. Payment for Access/Egress Signage Assembly will be made at the contract unit price per each. This price will be full compensation for procurement, installation, maintenance, and removal. This includes all labor, equipment, tools, and incidentals necessary to complete the item.

1. Payment Shall Be Made Under:

   015525-1 Traffic Control - per lump sum

   015525-2 Gate Guard - per hour

   015525-3 Gate Guard Shack - per lump sum

   015525-4 Access/Egress Signage Assembly – per each

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)

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

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.

G. Borrow Site restoration will include, but is not limited to, restoration of the borrow site to the original contours by means of clean fill, seeding and inspection by DEN Project Manager prior to any additional requirements from the City and County of Denver permitting process.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Erosion Control Measures - Temporary shall be measured as lump sum. There shall be no separate measurement for work associated with any temporary erosion control measures required and implemented during the life of the contract. The Contractor shall prepare and submit a Schedule of Values to the DEN Project Manager for his/her approval, prior to initial installation of any control measures.

B. Erosion Control – Water Log shall be measured as liner foot.

C. Borrow Site Restoration shall be measured per cubic yard. Restoration shall include excavation, hauling, placing, compaction, disposal (including disposal fees), and final seeding. There shall be no separate measurement for items incidental to the work to restore the borrow site.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. The Contractor shall be responsible for payment of all fees associated with review of environmental permit applications and processing of environmental permits.

B. Erosion Control Measures (Temporary)" payment will be made at the contract unit price per lump sum for work completed and accepted in-place, as described in the Schedule of Values. This price will be full compensation for furnishing all materials, all labor, equipment, tools, and incidentals necessary to complete this item, including the removal and disposal of such items in accordance with the contract documents and specifications.

C. Borrow Site Restoration payment will be made at the contract unit price per cubic yard. This price will be full compensation for furnishing all materials, all labor, equipment, tools, and incidentals necessary to complete this item, including the removal and disposal of such items in accordance with the contract documents and specifications.

1. Payment will be made under:

015719-1 Erosion Control Measures – Temporary - per lump sum

015719-2 Erosion Control Measures – Water Log – per linear foot

015719-3 Borrow Site Restoration – per cubic yard

END OF SECTION 015719

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 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

A. General: Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures including but not limited to the requirements of Executive Order 123, use products for patching that comply with requirements in Section 018113.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations," Section 018113.16 "Sustainable Design Requirements - LEED for Commercial Interiors," Section 018113.19 "Sustainable Design Requirements - LEED for Core and Shell Development."

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

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.

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

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.
2. Section 015719 "Temporary Environmental Controls" for environmental control requirements.
3. Section 024119 "Selective Demolition" for selective demolition of structures and other elements.
4. Section 099123 "Interior Painting" for interior painting of areas of cutting and patching.

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.

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. Comply with governing environmental protection regulations. Reference Section 015719 "Temporary Environmental Controls" for requirements.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions such as ice, flooding, and pollution.

2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosures. Vacuum carpeted areas. Professionally clean carpeted areas if required.

3. 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.

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 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

SECTION 017419

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 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.

1.2 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 LEED, Envision and other projects. Note that LEED and Envision projects may have additional requirements.

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.
3. Section 015719 "Temporary Environmental Controls" for environmental control procedures.

1.3 SECTION 016610 “STORAGE AND PROTECTION” FOR REQUIREMENTS RELATED TO MATERIALS STORAGE AND PROTECTION.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.
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

1.4 SUBMITTALS

A. Prior to the start of construction activities, 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. An electronic copy or 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. Prior to the start of any waste generating activities, 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 construction activity, the Contractor shall identify the waste stream that will be generated, waste handling and transportation method, disposal method, and identify the disposal facility utilized.
   b. If the Contractor anticipates generation of hazardous waste, the Contractor shall provide its EPA 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 and Training

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. The Contractor shall submit at the end of the project a summary of these records. The summary should include at a minimum the type of waste, quantity, method of disposal, date and location of disposal, and calculation of the waste diversion rate.

Waste diversion rate is calculated as the amount of material (in tons) diverted from landfill or incineration divided by the total material generated. Diverted materials can include all material that is recycled, composted, chipped, or in any way used in a higher and better use than landfilling or incineration.

PRODUCTS

1.5 DOCUMENTS

A. A list of all materials and products used. Examples include chemicals, solvents, fuels, curing compounds, etc.

1. An electronic copy or 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 2 - EXECUTION

2.1 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 on DEN property. These materials must be returned to the facility of origination or other permitted

facility for proper disposal.

E. Concrete slurry generated from sawcutting activities is accepted at the DEN North and South Concrete and Asphalt Recycle Yards at designated areas only. Prior notification and approval is required.

F. Any wastewater generated from construction activities may not be disposed of anywhere on DEN property, except as allowed by any permit (e.g. dewatering permit). These materials must be properly disposed of offsite.

G. Soil or water that is determined to be contaminated with materials not formally designated as hazardous must have specific waste management practices identified and included in the Waste Management Plan. This includes but is not limited to petroleum products and per- and polyfluoroalkyl substances (PFAS).

H. Unknown or questionable materials encountered during construction activities must be immediately reported to the DEN Communications Center at (303) 342-4200 and the DEN Project Manager.

PART 3 - MEASUREMENT

3.1 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 4 - PAYMENT

4.1 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.

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

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

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

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.

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, on a time and materials basis, for the time spent by the DEN Project Manager on re-inspection and related work, with a minimum charge of $2500:

Position	
Project Manager	
Quality Assurance Inspector	
Commissioning Agent	

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.

B. Subcontractor Payment Verification

1. The contractor shall submit a full report of subcontractor work performed, payments made, and outstanding payments due. This report shall include, at minimum, the following information.
   a. Project name
   b. Project number
   c. Date
   d. Name of Contractor

e. Name of all subcontractors, of all tiers, as listed in the bid as well as any subsequently submitted CM-02 forms, including the following information for each subcontracted firm:
   1) Total value of work performed
   2) Total amount paid to date
   3) Date of last payment
   4) Balance due
   5) Payment Terms
   6) Remaining balance to be paid
   7) Planned payment date

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 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 [system startup] [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 system startup 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.

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.
    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

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

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.

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.

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.

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 213113 – Electric-Drive, Centrifugal Fire Pumps
6. Section 213213 – Electric-Drive, Vertical-Turbine Fire Pumps
7. Section 220513 – Common Motor Requirements for Plumbing Equipment
8. Section 220519 – Meters and Gauges for Plumbing Piping
9. Section 220529 – Hangers and Supports for Plumbing Piping and Equipment
10. Section 220533 – Heat Tracing for Plumbing Piping
11. Section 220548 – Vibration and Seismic Controls for Plumbing Piping and Equipment
12. Section 220716 – Plumbing Equipment Insulation
13. Section 220719 – Plumbing Piping Insulation
14. Section 221116 – Domestic Water Piping
15. Section 230400 – Basic HVAC Requirements
16. Section 230513 – Common Motor Requirements for HVAC Equipment
17. Section 230519 – Meters and Gages for HVAC Piping
18. Section 230529 – Hangers and Supports for HVAC Piping and Equipment
19. Section 230533 – Heat Tracing for HVAC Piping
20. Section 230548.13 – Vibration Controls for HVAC
21. Section 230593 – Testing, Adjusting, and Balancing for HVAC
22. Section 230713 – Duct Insulation
23. Section 230716 – HVAC Equipment Insulation
24. Section 230719 – HVAC Piping Insulation
25. Section 230800 – Commissioning Of HVAC
26. Section 230900 – Instrumentation and Control for HVAC
27. Section 230923 – Direct Digital Control (DDC) System for HVAC

28. Section 230993 – Sequence of Operations for HVAC Controls
29. Section 230993.11 – Sequence of Operations for HVAC DDC
30. Section 260529 – Hangers and Supports for Electrical Systems
31. Section 260533 – Raceways and Boxes for Electrical Systems
32. Section 260536 – Cable Trays for Electrical Systems
33. Section 260539 – Underfloor Raceways for Electrical Systems
34. Section 260548 – Vibration and Seismic Controls for Electrical Systems

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.

C. Related Sections

D. Related Sections

1. Section 230800 "Commissioning of HVAC" and Section 260800 “Commissioning of Electrical” for commissioning process activities for HVAC&R systems, assemblies, equipment, components, and electrical systems.
2. Section 260800 - Commissioning of Electrical.

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 l 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 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.
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.
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 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
   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

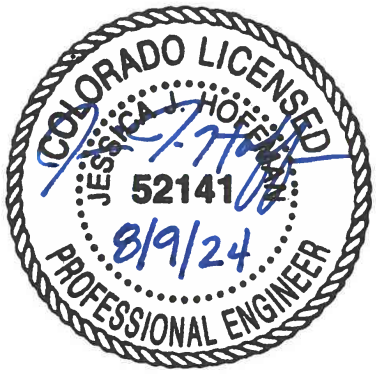
A. No separate measurement shall be made for work under this Section.

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



DEN

PROJECT MANUAL

GARDI
CONCOURSE A SOUTHEAST
(Gates A40, A42, A44 & A46)

DEN Contract Number: 202474451

VOLUME II

Division 02
TECHNICAL SPECIFICATIONS

Issued for Construction
09 August 2024

City and County of Denver Department of Aviation

Philip A. Washington, CEO

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Denver Water Specifications, current editions shall be aquired on the Denver Water website: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-construction-standards

The table of contents for the Denver Water Department specifications is intended to be representative of the scope of work for this project. Additional specifications may be referenced that are not included in this list, and can be found at the website location above.

CIVIL, MECHANICAL, ELECTRICAL, AND PLUMBING SPECIFICATIONS

END OF SECTION

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 (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 Federal (FAA) requirements outlined herein shall serve to supplement the DEN Division 01 requirements. In the event of a conflict between Item C-100 requirements and DEN Division 01, the DEN provisions shall govern.

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 on-site 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 paragraph100-8.

(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 013210 - Schedule.

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 DEN PM will provide written notice to the Contractor of any non-compliance 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
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

END OF ITEM C-100

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 (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 sublot 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 (X) for all sublot test values within the lot by using the following formula:

$$\mathbf{X = (x_1 + x_2 + x_3 + \ldots x_n) / n}$$

Where: X = Sample average of all sublot test values within a lot

$x_1, x_2, \ldots x_n$ = Individual sublot test values

n = Number of sublot test values

e. Find the sample standard deviation (S_n) by use of the following formula:

$$\mathbf{S_n = [(d_1^2 + d_2^2 + d_3^2 + \ldots d_n^2)/(n-1)]^{1/2}}$$

Where: S_n = Sample standard deviation of the number of sublot test values in the set

$d_1, d_2, \ldots d_n$ = Deviations of the individual sublot test values $x_1, x_2, \ldots$ from the average value X

that is: $d_1 = (x_1 - X)$, $d_2 = (x_2 - X) \ldots d_n = (x_n - X)$

n = Number of sublot 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
A-4 = 98.35
n = 4

2. Calculate average density for the lot.

$X = (x_1 + x_2 + x_3 + . . . x_n) / n$
$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$
X = 97.95% 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.

$X = (x_1 + x_2 + x_3 \ldots n) / n$

$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$

$X = 3.57\%$

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:

Greater than (97.95 + 1.463 × 1.15) = 99.63%

OR

less than (97.95 - 1.463 × 1.15) = 96.27%.

Table 1. Table for Estimating Percent of Lot Within Limits (PWL)

Percent Within Limits (P_L and P_U)	Positive Values of Q (Q_L and Q_U)							
	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

Percent Within Limits (P_L and P_U)	Positive Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
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

Percent Within Limits (P_L and P_U)	Negative Values of Q (Q_L and Q_U)							
	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

Percent Within Limits (P_L and P_U)	Negative Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

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

ITEM P-101 PREPARATION/REMOVAL OF EXISTING PAVEMENTS

DESCRIPTION

101-1.1 This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and removal of other miscellaneous items outlined within the project limits. The work shall be accomplished in accordance with these specifications and the applicable plans.

The Owner reserves the right to keep all items to be removed/demolished. Prior to demolition, the Contractor shall coordinate with the Owner to determine the salvage requirements. The Contractor shall dispose of material not salvaged at a licensed disposal site or as directed by the DEN Project Manager. Material salvaged and not turned over to the Owner shall become the property of the Contractor. The Contractor shall refer to the Demolition Plans for specific project demolition requirements.

The Contractor shall protect personnel from possible airborne contaminants such as dried fecal matter (bird droppings), concrete dust, and metal dust. The Contractor is responsible for determining compliance with OSHA safety requirements. Do not begin demolition or deconstruction until authorization is received from the DEN Project Manager. Remove rubbish and debris from the project site; do not allow accumulations on airfield pavements or infield areas. Remove rubbish and debris from airport property at a minimum of weekly, or as otherwise directed by the DEN Project Manager. In the interest of occupational safety and health, all work shall be performed in accordance with the DEN ROCIP provisions, The DEN General Requirements, the Construction Safety and Phasing provisions, and all pertinent OSHA safety requirements.

Prevent the spread of dust and debris on airfield pavements and avoid the creation of a nuisance and/or hazard in the surrounding area. Sweep and/or vacuum remove dust and debris from pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to aircraft.

The Contractor shall notify all utility, 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 Contractor shall refer to and also consider as integral contractual requirements for demolition, the DEN Division 01 General Requirements.

EQUIPMENT AND MATERIALS

101-2.1 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.

101-2.2 Materials used to cap off pipelines remaining in the ground shall be of the size and type normally used for this operation. Pipe pressure grouting material shall be P-153 CLSM or other material, as approved by the DEN PM.

CONSTRUCTION

101-3.1 Blasting. Blasting will not be permitted on this project.

101-3.2 Removal Items. Remove items where shown on the plans. Care shall be taken not to damage any items to be salvaged and returned to the Owner or existing items which are to remain in operation.

101-3.3 Protection. Before beginning any deconstruction or demolition, record existing conditions in the presence of the DEN PM, showing the condition of structures and other facilities adjacent to areas of alteration or removal. Record of existing conditions shall be obtained by way of photographic or video log, as required by the DEN PM. Include in record the elevation of the top of inlets, elevation of inlet barrel segments, manhole/inlet floor slabs, possible conflicting plumbing lines, the location and extent of existing cracks and other damages.

Take necessary precautions to avoid damage to existing items and/or portions of existing items that will remain in place, to be reused. Repair or replace damaged items, as approved by the DEN PM. Coordinate the work of this section with all other work indicated.

101-3.4 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 sawcut 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. Full-depth saw cuts shall be made perpendicular to the slab surface. The Contractor shall saw through the full depth of the slab including any dowels at the joint, removing the pavement and installing new dowels as shown on the plans and per the specifications. Where the perimeter of the removal limits is not located on the joint and there are no dowels present, the perimeter shall be saw cut the full depth of the pavement. 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 foot straightedge. Saw-cutting depth may vary nominally, and no extra payment will be allotted for varying depths. Saw-cutting shall be considered incidental to the associated work.

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.

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 facility structures, cables, utility ducts, pipelines, or drainage structures under the pavement. The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Spall and underbreak repair shall be in accordance with the plans, at the Contractor's expense. Any underlaying material that is to remain in place, shall be recompacted, repaired, and/or replaced, as shown on the plans. Adjacent areas damaged during repair shall be repaired or replaced at the Contractor's expense.

Demolition activities for PCCP slabs above the DEN Concourse basement structure roof slab, requires special care and attention.. Contractor shall submit a plan, in accordance with the plans and specifications, that outlines non-destructive removal methods for removing PCCP slabs without damage to the Concourse basement roof slab. The plan shall be reviewed and approved by the DEN Project Manager, during the demolition pre-work meeting, in advance of commencing with demolition operations. Damage caused by the Contactor to the Concourse basement structure will be repaired by the Contactor at no expense to the City (DEN). Operational impacts damages incurred as a result of basement repair work, including but not limited to gate apron gate closures, concessions impacts, DEN facilities impacts, sterile area closures, etc., shall be assessed in-whole to the Contractor.

Demolition activities for PCCP slabs near the concourse walls, concourse center core, under ceilings and directly adjacent to the basement slab require special care. Contractor shall submit a plan, in accordance with the plans and specifications, that outlines methods for removing the PCCP slabs without damage to the Concourse building. The plan shall be reviewed and approved by the DEN Project Manager, during the demolition pre-work meeting, in advance of commencing with demolition operations. If hammering

methods are utilized for PCCP demolition, the Contractor will be required to utilize lower energy class hammers to perform the work. The equipment selected shall be submitted for review and approval by DEN Project Manager.

If the material is to be wasted on the airport site, it shall be reduced in accordance with Item P-159.

b. Asphalt pavement removal. This item shall consist of saw-cutting and removal of existing bituminous concrete pavement (including base materials). Asphalt pavement to be removed shall be cut to the full depth of the bituminous material, around the perimeter of the area to be removed. 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.

Asphalt pavement to be removed in conjunction with full-depth asphalt pavement removal shall be completed by milling operations, or other method, as directed by the DEN PM. Contractor shall coordinate with the DEN PM for asphalt millings salvage, stockpile, and/or placement requirements. If the material is to be wasted on the airport site, it shall meet the requirements of Item P-159.

Removal operations shall be carefully controlled to prevent damage to the adjacent pavement and to underlying materials to remain in place. Areas which are damaged during construction shall be repaired at the Contractor's expense.

c. Repair or Removal of Base, Subbase, and/or Subgrade. All failed material including surface, base course, subbase course, and subgrade shall be removed and repaired as shown on the plans, or as directed by the DEN Project Manager. Materials and methods of construction shall comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process shall be repaired at the Contractor's expense.

101-3.5 Preparation of joints and cracks prior to overlay/surface treatment. Remove all vegetation and debris from cracks to a minimum depth of 1 inch. If extensive vegetation exists, treat the specific area with a concentrated solution of a water-based herbicide, approved by the DEN Project Manager. Fill all cracks greater than 1/4 inch 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, not to exceed ¼ inch. Any excess joint or crack sealer shall be removed from the pavement surface.

Wider cracks (over 1-1/2 inch wide), along with soft or sunken spots, indicate that the pavement or the pavement base should be repaired or replaced as stated below.

Cracks and joints may be filled with a mixture of emulsified asphalt and aggregate. The aggregate shall consist of limestone, volcanic ash, sand, or other material that will cure to form a hard substance. The combined gradation shall be as shown in the following table.

Gradation

Sieve Size	Percent Passing
No. 4	100
No. 8	90-100
No. 16	65-90
No. 30	40-60
No. 50	25-42
No. 100	15-30
No. 200	10-20

Up to 3% cement can be added to accelerate the set time. The mixture shall not contain more than 20% natural sand without approval in writing from the DEN PM.The proportions of asphalt emulsion and aggregate shall be determined in the field and may be varied to facilitate construction requirements. Normally, these proportions will be approximately one part asphalt emulsion to five parts aggregate by volume. The material shall be poured or placed into the joints or cracks and compacted to form a void-less mass. The joint or crack shall be filled to within +0 to -1/8 inches of the surface. Any material spilled outside the width of the joint shall be removed from the pavement surface prior to constructing the overlay. Where concrete overlays are to be constructed, only the excess joint material on the pavement surface and vegetation in the joints need to be removed.

101-3.6 Removal of Foreign Substances/contaminates prior to overlay, seal-coat, or re-marking.

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.

Method for removal shall be approved by the DEN PM, prior to commencing with removal operations. On asphalt pavements, water blasting will be allowed only if it can be demonstrated that no major damage to the asphalt pavement occurs; otherwise, grinding will be required. Sandblasting will not be permitted. Major damage is defined as changing the properties of the pavement or removing pavement over 1/8 inch deep. On concrete pavements, water blasting shall be used for all removals; sandblasting will not be permitted.

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 re-painting 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.

Chemicals, high-pressure water, heater scarifier (asphaltic concrete only), cold milling, rotary grinding, or sandblasting may be used, only as approved by the DEN PM in advance of removal operations. 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 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.

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 airfield pavement. All wastes shall be disposed of off Airport property, unless otherwise indicated in the contract documents.

101-3.7 Concrete spall or failed asphaltic concrete pavement repair.

a. Repair of concrete spalls in areas to be overlaid with asphalt. The Contractor shall repair all spalled concrete as shown on the plans or as directed by the DEN PM. The perimeter of the repair

shall be saw cut a minimum of 2 inches outside the affected area and 2 inches deep. The deteriorated material shall be removed to a depth where the existing material is firm or cannot be easily removed with a geologist pick. The removed area shall be filled with asphalt mixture with aggregate sized appropriately for the depth of the patch. The material shall be compacted with equipment approved by the DEN PM until the material is dense and no movement or marks are visible. The material shall not be placed in lifts over 4 inches in depth. This method of repair applies only to pavement to be overlaid.

b. Asphalt pavement repair. The Contractor shall repair all spalled concrete as shown on the plans or as directed by the DEN PM. The failed areas shall be removed as specified in paragraph 101-3.4. All failed material including surface, base course, subbase course, and subgrade shall be removed. Materials and methods of construction shall comply with the applicable sections of these specifications.

101-3.8 Cold milling. Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The milling machine or grinder shall operate without tearing or gouging the underlaying 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 of off Airport property, unless otherwise 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 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 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 off the airport, unless otherwise designated in 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 of off Airport property, unless otherwise designated on the plans.

101-3.9 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.

101-3.10 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.

101-3.11 Preparation of Joints in Rigid Pavement prior to resealing. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the DEN PM, that the method used cleans the joint and does not damage the joint.

a. Removal of Existing Joint Sealant. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry.

b. Cleaning prior to sealing. Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces will be surface-dry prior to installation of sealant.

c. Joint sealant. Joint material and installation will be in accordance with Item P-605 and Item P-604, as noted in the plans.

101-3.12 Preparation of Cracks in Flexible Pavement prior to sealing. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the DEN PM, that the method used cleans the cracks and does not damage the pavement.

a. Preparation of Crack. Widen crack with router by removing a minimum of 1/16 inch from each side of crack. Immediately before sealing, cracks will be blown out with a hot air lance combined with oil and water-free compressed air.

b. Removal of Existing Crack Sealant. Existing sealants will be removed by routing. Following routing, any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.

c. Crack Sealant. Crack sealant material and installation will be in accordance with Item P-605.

101-3.13 Buried Pipelines. 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 drawings shall be located by the Contractor by potholing to verify location, depth, and usage. The Contractor shall remove all utility pipes and lines included in the project 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 outside the limits of construction and not less than 15 feet below the finished grade level shall be removed. The Contractor shall notify oil and gas facility owners and the DEN PM in writing, 30 days in advance of requiring work in areas currently occupied by oil and gas wells and buried pipelines.

Piping a minimum of 15 feet below finished grade elevations, or plan excavation, may be left in place or removed and salvaged at the discretion of the Contractor. 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 PM and included on the "as-built" drawings.

Pipes to be abandoned in-place may be pressure grouted, at DEN PM discretion, in order to prevent collapse of the pipe under loading conditions. The pipe shall be pressure grouted with P-153 CLSM or other material, as approved by the DEN PM.

101-3.13.1 Trenching. The removal of cover on top of and surrounding the abandoned pipelines shall be performed without damaging the pipeline. All trench sidewalls shall be properly sloped or benched and/or braced, shored or sheeted to afford safe working conditions, to protect adjacent pipelines, and to prevent caving.

a. Testing. The Contractor shall test the exposed trench excavation and the pipeline for dangerous or explosive gases and to positively determine that the line has been emptied, cleaned, and/or purged, prior to performing any further operations.

b. Cutting of Pipeline and Storm Sewers. Extreme care shall be exercised whenever the pipeline or storm sewer to be removed is cut into, especially the first cut on the abandoned pipeline. The Contractor shall use a method to cut the pipeline into sections for removal which provides safety for workers and equipment. The initial cut shall not be made with a cutting torch.

1) Backfilling. If required, select embankment (1" maximum size), per Item P-152 (or placement of CLSM per Item P-153) to 12-inches over the top of the pipe shall be completed before backfilling operations are started.

The Contractor shall take all necessary precautions to protect the pipe from any damage, movement or shifting. In general, backfilling shall be performed by pushing the material from the end of the trench into, along and directly over the pipe so that the material will be applied in the form of a rolling slope rather than by side filling which may damage the pipe. Backfilling from the sides of the trench will be permitted after sufficient material has first been carefully placed over the pipe to such a depth as to protect the pipe.

Compaction equipment used above the pipe zone shall be of a type that does not damage the pipe. Provide for the proper maintenance of traffic flow and accessibility as may be necessary. Make adequate provisions for the safety of property and persons. Temporary cribbing, sheeting, or other timbering shall be removed unless specifically authorized in writing. Dewatering shall be continued until the trench is completely backfilled. Brush, stumps, logs, planking, disconnected drains, boulders, etc. shall be removed from the material to be used for backfilling the trench.

2) General Compaction Requirements. Requirements of this section shall apply unless more stringent requirements are established by the local agency involved. Trench backfill shall be compacted to the requirements of Item P-152.

3) Mechanical Compaction. Method of compaction shall be at Contractor's option, as approved by the DEN Project Manager. The Contractor shall be responsible to provide the proper size and type of compaction equipment and select the proper method of utilizing said equipment to attain the required compaction density. In-place compaction tests shall be made. Contractor shall remove and re-compact material that does not meet specified requirements.

c. Removal of Water and Residual Petroleum Products from Pipelines. Any pipeline containing water or residual petroleum products, after abandonment by the pipeline owner, shall have the water or the residual products removed from the pipeline, by the Contractor, using a nitrogen purge, steam, or other approved means. The material removed from the pipeline shall be hauled away and disposed of properly. The Contractor shall assume that all pipelines to be removed contain significant amounts of residual products that must be disposed of offsite.

101-3.14 Buried Utility Lines. The Contractor shall remove all abandoned electrical, telephone, and other utility lines whether shown on the contract drawings or not. All known lines are shown, but there may be other unknown abandoned lines in the area. It shall be the Contractor's responsibility to check the status of all abandoned lines. Care shall be taken to assure that all abandoned electric lines are not live and cannot be activated accidentally.

101-3.15 Electrical. The Contractor shall remove all abandoned cable, cable identified to be removed, ductwork, base cans including concrete encasement and all light fixtures, signs, and duct markers within the construction limits of pavements to be removed, widened or constructed, or as shown on the Drawings. Protect existing airfield lighting fixtures and base plates from damage and deliver them to the Airport for storage, as directed by the DEN PM. Discard all base cans, conduit, transformers and cable off-site. The Electrical Contractor shall provide written documentation to the DEN PM that electrical cable has been removed prior to slab saw-cutting and demolition.

101-3.16 Foundations and Slabs on Grade. All structures at or above grade and to a depth of not less than 15-feet below the final finished grade line and within 10 feet horizontally of the construction limits shall be removed, as indicated on the plans.

101-3.17 Ground Surface Repair. The Contractor shall rough grade and compact areas affected by demolition to maintain site grades and contours. All holes remaining after demolition operations shall have sides broken down to flatten out the slopes, and shall be filled with acceptable material, moistened and properly compacted in layers to the density required in Item P-152. The ground surface area repaired shall properly drain and that water will not pond.

101-3.18 Water Wells. There is a possibility that water wells are located in work areas. The wells are permitted by the State of Colorado and shall be abandoned in accordance with current Revised and Amended Rules and Regulations of the Board of Examiners of Water Well Construction and Pump Installation Contractors. The Contractor shall employ a licensed water well contractor to demolish and abandon existing water wells and provide necessary documentation to the State of Colorado Agencies and Boards, as required.

101-3.19 Existing Roadways. Roadway demolition shall consist of all portions of asphalt and concrete roadway, including surface courses and base materials, within the project limits, including all existing haul roads and any alternate access roads identified in the plans.

101-3.20 Removal of Signs and Delineators. Sign demolition shall consist of the removal and disposal of the existing signs and delineators, including their foundations and posts, within the project limits, along all existing haul roads and any alternate access road**.**

101-3.21 Inspection Points. Upon completion of demolition work, and prior to backfilling operations, the DEN Project Manager shall inspect the Contractor's work. After backfilling and grading operations, the Contractor's Quality Control Inspector shall perform inspection and final acceptance, per Division 1 General Requirements Section 014510 – *Contractor Quality Control* and Section 014520 *Contractor Quality Control Program* – FAA.

101-3.22 Waste Disposal. All waste material generated as a result of demolition operations shall be disposed of as indicated in the plans; contract documents, including Section 017419 Construction Waste Management and Disposal; and the local laws and regulations pertaining to disposal of these materials**.**

METHOD OF MEASUREMENT

101-4.1 Remove Concrete Pavement – Plain (Full-Depth). Measurement of removal of plain concrete pavement shall be made per square yard, based on the area shown on the plans. Any pavement removed outside the designed 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. The thickness of the existing material to be removed (including PCCP, base materials, and subbase materials) 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 saw-cutting, PCCP excavation, cement treated subbase excavation, lime treated subgrade excavation, hauling, and disposal (including disposal fees) of pavement necessary to facilitate removal.

101-4.2 Remove Concrete Pavement – Reinforced (Full-Depth). Measurement of removal of reinforced concrete pavement shall be made per square yard based on the area shown on the plans. Any pavement removed outside the designed 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. The thickness of the existing material to be removed (including PCCP, base materials, and subbase materials) 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 saw-cutting, PCCP excavation, cement treated subbase excavation, lime treated subgrade excavation, hauling, and disposal (including disposal fees) of pavement necessary to facilitate removal, hauling, and disposal (including disposal fees) of pavement necessary to facilitate removal.

101-4.3 Remove Concrete Pavement – Plain (Slab Only). Measurement of removal of plain concrete pavement (slab only) shall be made per square yard, based on the area shown on the plans. Contractor shall remove panels in manner so as to protect and prevent damage to the underlying cement-treated base course and structures. Damage caused to the underlying elements shall be repaired by the Contactor at no expense to DEN. The thickness of the existing PCCP 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 saw-cutting, excavation, hauling and disposal (including disposal fees) of pavement necessary to facilitate removal.

101-4.4 Remove Concrete Pavement – Reinforced (Slab Only). Measurement of removal of plain concrete pavement (slab only) shall be made per square yard, based on the area shown on the plans. Contractor shall remove panels in manner so as to protect and prevent damage to the underlying cement-treated base course and structures. Damage caused to the underlying base course shall be repaired by the Contactor at no expense to DEN. The thickness of the existing PCCP 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 saw-cutting, excavation, hauling and disposal (including disposal fees) of pavement necessary to facilitate removal.

101-4.5 Grind Existing CTB. Measurement for Grind Existing CTB shall be made per square yard. Grinding existing CTB shall include all removal, excavation, hauling and disposal (including disposal fees) necessary to facilitate removal.

101-4.6 Remove PVC Drainpipe and Area Drain. Measurement for removal of drainpipe shall be made per linear foot for all pipe types outlined in the contract (RCP, PVC, CMP, steel, underdrain, etc.). Measurement for remove area drain shall be made per each. The pipe and drains shall be disposed of off-site. Removal shall include all excavation, removal, pipe cap for abandonment, hauling, and disposal (including disposal fees).

101-4.7 Remove Storm and Sanitary Manhole Structure. Measurement for removal of sanitary and storm manhole structures shall be made per each. Removal shall include all excavation, hauling, and disposal (including disposal fees).

101-4.8 Remove Trench Drain. Measurement for Remove Trench Drain shall be made per linear foot. The trench drain shall be disposed of off-site. Removal shall include all excavation, hauling, and disposal (including disposal fees).

101-4.9 Remove Bollards. Measurement of remove bollards shall be made per each. Materials shall be disposed of offsite. Removal shall include supports, anchoring, concrete repair, hauling and disposal (including disposal fees).

101-4.10 Remove and Reinstall Vehicle Clearance Bar. Measurement of Remove Clearance Bars shall be made per each. Materials shall be stored of offsite. Removal shall include the entire clearance bar, supports, anchoring, hauling and reinstallation.

101-4.11 Remove Fire Hydrant. Measurement for Remove Fire Hydrant shall be made per each. The hydrant shall be disposed of off-site. Removal shall include all disassembly, excavation, hauling, and disposal (including disposal fees).

101-4.12 Remove Steel Waterline. Measurement for Remove Steel Waterline shall be made per linear foot. The waterline shall be disposed of off-site. Removal shall include all disassembly, excavation, hauling, and disposal (including disposal fees).

101-4.13 Remove Pipe and Cleanouts. Measurement for pipe removals shall be made per linear foot for all pipe types outlined in the contract (RCP, PVC, CMP, steel, underdrain, etc.). Measurement for removal of cleanouts shall be made per each. The pipe and cleanouts shall be disposed of off-site. Removal shall include all excavation, hauling, and disposal (including disposal fees).

101-4.14 Remove Metal Expansion Joint. Measurement for removal of metal expansion joint shall be made per linear foot. Removal shall include all excavation, removal, hauling, and disposal (including disposal fees).

101-4.15 Remove and Reinstall Metal Plate. Measurement of remove and reinstall metal plate shall be made per each. The metal plate, located in front of the recycle compactor shall be removed, stored, and reinstalled after the paving work is completed. This item shall include all removal, storage, hauling, and reinstallation.

101-4.16 Removal of Fire Hydrant Concrete Islands. Removal of fire hydrant concrete islands shall be made per square yard. Removal shall include all excavation, hauling, and disposal (including disposal fees).

101-4.17 Removal of Raised Concrete Pad at Gate House. Removal of existing raised concrete pad at the gate house shall be made per square yard. Removal shall include all excavation, hauling, and disposal (including disposal fees).

101-4.18 Removal of Raised Concrete and Median Curb. Removal of Concrete Curb shall be made per linear foot. Removal of Median Curb shall be made per square yard. Removal of Curb Stops shall be made per each. Removal shall include all excavation, hauling, and disposal (including disposal fees).

101-4.19 Removal of Railing. Removal of existing concrete railing shall be made per linear foot. Materials shall be stored of offsite as indicated on the plans. Removal shall include the railing, supports, anchoring, hauling, reinstallation, and disposal (including disposal fees).

101-4.20 Remove and Reinstall Concrete Column Base Protection. Measurement for Remove and Reinstall Concrete Column Base Protection shall be made per each. The work shall include removal, salvage, storage, and re-installation.

101-4.21 Removal of Gate House. Removal of existing Gate House shall be made per each. Removal shall include all demolition, disassembly, caping, hauling, and disposal (including disposal fees). The gate house shall not be disposed of on DEN property. The portable heating, ventilation, and air conditioning (HVAC) unit will need to be disposed of properly off-site.

101-4.22 Remove Potable Water Cabinet. Measurement of Removal of Potable Water Cabinet shall be per each. Removal shall include all hauling and disposal (including disposal fees). Electrical demolition associated with the removal of the PWCs shall be incidental to the removal of the PWCs, including cable back to source, exposed conduit to the face of the building, plug conduit, and associated heat trace cable along the supply and return water lines being removed. Circuit schedules in panelboards shall be updated to indicate circuit breakers as spare.

101-4.23 Removal of Domestic Water Line. Removal of Domestic Water Line shall be made per linear foot. Removal shall include all disassembly, caping, hauling, and disposal (including disposal fees).

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, excavation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

Item P-101-5.1	Remove Concrete Pavement - 12" Reinforced (Slab Only) - per square yard
Item P-101-5.2	Remove Concrete Pavement - 17" Reinforced (Full-Depth) - per square yard
Item P-101-5.3	Remove Concrete Pavement - 17" Reinforced (Full-Depth - P-610) - per square yard
Item P-101-5.4	Remove Concrete Pavement - 17" Plain (Full Depth) - per square yard
Item P-101-5.5	Remove Concrete Pavement - 17" Plain (Slab Only) - per square yard
Item P-101-5.6	Remove Concrete Pavement - 21" Reinforced (Full Depth) - per square yard
Item P-101-5.7	Remove Concrete Pavement - 21" Plain (Full Depth) - per square yard
Item P-101-5.8	Remove 3” PVC Drain Pipe - per linear foot
Item P-101-5.9	Remove Area Drain - per each
Item P-101-5.10	Cap 3" PVC Drain Pipe at Main - per each
Item P-101-5.11	Remove Storm Manhole (SDG) – per each
Item P-101-5.12	Remove Sanitary Manhole (SAG) – per each
Item P-101-5.13	Remove Trench Drain – per linear foot
Item P-101-5.14	Remove Bollard – per each
Item P-101-5.15	Remove, Store, and Reinstall Vehicle Clearance Barrier – per each
Item P-101-5.16	Remove Fire Hydrant – per each
Item P-101-5.17	Remove 6" Steel Waterline – per linear foot
Item P-101-5.18	Remove Existing Underdrain Pipe – per linear foot
Item P-101-5.19	Remove Existing Underdrain Cleanouts – per each
Item P-101-5.20	Remove Existing GI 6” PVC Pipe – per linear foot
Item P-101-5.21	Remove Existing GI Cleanout – per each
Item P-101-5.22	Remove Metal Expansion Joint – per linear foot
Item P-101-5.23	Remove and Reinstall Metal Plate – per each
Item P-101-5.24	Remove Fire Hydrant Concrete Island – per square yard
Item P-101-5.24	Remove Existing Raised Concrete Curb – per linear foot
Item P-101-5.25	Remove Existing Raised Concrete Pad (Gate House) – per square yard
Item P-101-5.26	Remove Existing Concrete Curb Stops – per each
Item P-101-5.27	Remove Existing Raised Median Curb – per square yard
Item P-101-5.28	Remove, Store, and Reinstall Concrete Railing Barrier at A40 – per linear foot
Item P-101-5.29	Remove Existing Concrete Railing – per linear foot

Item P-101-5.30	Remove and Reinstall Concrete Column Base Protection – per each
Item P-101-5.31	Remove Existing Gate House – per each
Item P-101-5.32	Remove Potable Water Cabinet – per each
Item P-101-5.33	Remove PWC Domestic Water Line – 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 150/5380-6	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

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, utility applications, 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 also consist of material cut within the project construction limits and placed within the construction limits as embankment, structural fill, hauled to borrow site, or hauled off-site. 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 Embankment. Borrow Embankment 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, 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 Project Manager, in accordance with the requirements of P-152-2.12. Alternatively, the material may simply be stockpiled, at the discretion of the DEN Project Manager.

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 Project Manager.

Material found to contain contaminates 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 contaminates. 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 Imported Material Conformance Testing. Material conformance testing will be required before or during excavation for sourcing confirmation and approval, and at intervals during placement of select fill materials. Gradation characteristics and Atterberg limits be tested every 5,000 cubic yards for Lower-Select Embankment material. For the Upper-Select Fill Material, Gradations and Atterberg limits testing will be performed for every 2,500 cubic yards of excavated material. Water soluble sulfate tests shall be performed for every 1,000 cubic yards of Upper-Select Material. Remolded swell-consolidation characteristics shall be determined every 10,000 cubic yards for both select fill materials.

a. 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.

b. Information Submittals. Contractor shall submit the following to the DEN Project Manager for approval, prior to commencing with earthwork activities:

1. Geotechnical Testing Agency Qualifications: ASTM E 329 and ASTM D 3740 certifications.
2. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows: Classification (ASTM D 2487), Laboratory compaction curve (ASTM D 698).
3. Select Embankment Material Plan, in accordance with P-152-2.6.

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 Project Manager. 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 Project Manager. All unsuitable material shall be disposed of in waste areas as shown on the plans, or off Airport property, as applicable to the type of waste material. 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 Project Manager.

When the Contractor’s excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued, and the DEN Project Manager shall be notified per Section 70, Paragraph 70-20. At the direction of the DEN Project Manager, 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, to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 6-inches 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 Project Manager, 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.

The Contractor shall suspend all earthmoving activities when wind speeds exceed 30 mph, in accordance with Section 015719.

Blasting shall not be permitted.

152-2.2 Pre-Work Meeting. Contractor shall conduct a pre-work conference at the location, date, and time designated by the DEN Project Manager. Contractor shall prepare a plan to review the methods and procedures related to earthmoving, including, but not limited to, the following:

- Soils location and identification plan to include soil profiles, depth, and lateral extent
- Soils contamination testing plan
- Soils disposal and waste management plan
- Personnel and equipment needed to make progress and avoid delays
- Coordination of work with utility locator service(s)
- Field Quality Control Plan (QCP)

152-2.3 Field Conditions. Contractor shall adhere to the following during earth-moving operations:

a. Existing Utilities. Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted in writing by the DEN Project Manager, and then only after arranging to provide temporary utility services according to requirements indicated:

(1) Notify DEN Project Manager not-less-than two (2) days in advance of proposed utility interruptions.

(2) Do not proceed with utility interruptions without DEN Project Manager's written permission.

(3) The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by someone other than the Contractor; for example, the utility owner, unless otherwise shown on the plans to be removed by the Contactor. 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 Project Manager. All excavated foundations shall be backfilled with suitable material and compacted as specified.

(4) Demolish and completely remove from the site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services, if lines are active.

b. Traffic. Minimize interference with adjoining Taxiways/lanes, VSRs, roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations:

(1) Do not close or obstruct Taxiways/lanes, VSRs, streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

(2) Provide alternate routes around closed or obstructed traffic ways, if required by Owner or authorities having jurisdiction.

c. Utility Locator Service. Contact the Utility Notification Center of Colorado (Call 811 or 800-922-1987) for the area where the Project is located, before beginning demolition and earth-moving operations.

d. Do not commence earth-moving operations until temporary site fencing and erosion and sedimentation control measures specified in Section 015210 "Temporary Facilities" and Section 015719 “Temporary Environmental Controls” are in place.

152-2.4 Dewatering. Contractor shall dewater excavations in accordance with the following provisions:

a. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding the project site and surrounding areas.

b. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation:

1) Re-route surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

2) Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required

c. Dewatering and temporary drainage will not be paid for separately, but shall be considered incidental to the applicate work items.

152-2.5 Excavation. No excavation shall be started until the work has been staked out by the Contractor, and the DEN Project Manager has obtained from the Contractor the survey notes of the elevations and measurements of the ground surface. The Contractor and DEN Project Manager 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 prior to commencement of the work.

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 and a paper copy of the original topographic map will be issued to the Contractor, upon request by the Contractor and approval of the DEN Project Manager.

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 Project Manager 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 Project Manager. 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 Project Manager. 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 Project Manager 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 Project Manager. 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 Project Manager. All over-break shall be graded or removed by the Contractor and disposed of as directed by the DEN Project Manager. The DEN Project Manager 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 Project Manager 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 Project Manager. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

152-2.6 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 Project Manager. 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 contaminates 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 Project Manager. The Contractor shall notify the DEN Project Manager 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.

152-2.7 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 Project Manager. 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.

152-2.8 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 contaminates or hazardous materials shall be handled in accordance with the provisions of Section 017419.

152-2.9 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.

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 Reconditioning."

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 Project Manager.

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 (¾-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 Project Manager, prior to implementation. Subgrade Bridging shall be measured and paid for as “Subgrade Remediation”, as required via contract amendment.

152-2.10 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.

152-2.11 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 Project Manager, 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 Project Manager 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 Project Manager. 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 Project Manager.

152-2.12 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 Project Manager. 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 ±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 Project Manager.

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 Project Manager and provide the test results upon completion to the DEN Project Manager for acceptance. If the specified density is not attained, the area represented by the test or as designated by the DEN Project Manager 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 Project Manager.

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 Project Manager 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 Project Manager.

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 ."

152-2.13 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 Project Manager. Apply a minimum of 4 coverages, or as specified by the DEN Project Manager, 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.

152-2.14 Compaction Requirements. The subgrade under areas to be paved shall be compacted to a depth of 12-inches (8-inches, if Contactor cannot demonstrate competent result, per P-152-2.11 Control Strip) and to a density of not less than 95 percent of the maximum dry density, 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 as determined by ASTM D698.

The material to be compacted shall be within ±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 3/4 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 Project Manager, and density test results shall be furnished upon completion to the DEN Project Manager 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 Project Manager and the finished subgrade shall be maintained.

152-2.15 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.

152-2.16 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.

152-2.17 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.

152-2.18 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.

152-2.19 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 Project Manager.

152-2.20 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.

152-2.21 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 Project Manager. The Contractor shall perform all final smoothness and grade checks in the presence of the DEN Project Manager. 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 the P-501 PCCP panel grid joint points (20' x 20') 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.

152-2.22 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 Project Manager, 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.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as directed by the DEN Project Manager. Topsoil shall be placed overtop all disturbed areas, as directed by the DEN Project Manager, for reclamation of borrow, embankment, and staging areas.

152-2.23 Restoring Borrow Areas. The Contractor shall, upon completion of his borrow excavation activities, prepare the borrow site(s) for topsoiling and seeding, and restore the borrow areas per DEN Project Manager direction, 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 Project Manager. 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 seeding, if required by the DEN Project Manager. Treatment may include discing, harrowing, culti-packing or other means as approved by the DEN Project Manager. 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 Project Manager, at no additional cost to the Owner.

e. Restore the borrow area with topsoil per DEN Project Manager direction.

Disturbed areas shall be reclaimed in accordance with the provisions of Section 015719.

All work required to prepare and restore 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** to be paid for shall be the number of cubic yards measured in its original position and hauled to site. 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. This material shall be hauled to the location approved by DEN Project Manager.

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. Disposal site shall be approved by DEN Project Manager. 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 Reconditioning** of the lower select to be paid for shall be the number of square yards measured in its original position, accepted by the DEN PM.

152-3.7 The quantity of **Subgrade Remediation** of the lower select to be paid for shall be the number of square yards measured in its original position, accepted by the DEN PM.

BASIS OF PAYMENT

152-4.1 Unclassified Excavation 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.

152-4.4 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 Reconditioning of the lower select 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.

152-4.6 Subgrade Remediation of the lower select shall be made at the contract unit price per square yard. This price shall be full compensation for additional proofrolling, testing, coordination, and determination of failing subgrade, importing material, and hauling. This price shall also include the furnishing all materials, labor, equipment, tools, and incidentals necessary complete the item.

Payment will be made under:

Item P-152-4.1 Unclassified Excavation - per cubic yard

Item P-152-4.2 Waste Excavation - per cubic yard

Item P-152-4.3 Borrow Embankment - per cubic yard

Item P-152-4.4 Subgrade Reconditioning – per square yard

Item P-152-4.5 Subgrade Remediation – 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.

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^3 (600 kN-m/m^3))
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^3 (2700 kN-m/m^3))
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

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, for P-220 Cement-Treated Soil Base Course repairs, at other locations shown on the plans or as directed by the DEN PM.

MATERIALS

153-2.1 Materials.

a. Cement. Cement shall conform to the requirements of ASTM C150 Type V. ASTM C595 Type IP, IS, IL cement may be used subject to DEN PM approval. Any cement used shall have a maximum sulfate resistance of 0.040% at 14 days (Percent expansion).

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 Bank, shall have red color added.

MIX DESIGN

153-3.1 Proportions. The Contractor shall submit, to the DEN PM, 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 DEN PM 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 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 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 DEN PM. 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 DEN PM.

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 and rising. Mixing and placement shall stop when the air temperature is 40°F and falling or when the anticipated air or ground temperature will be 35°F 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.

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, the material may be rejected by the DEN PM 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 is obtained. The Contractor shall be responsible for providing evidence to the DEN PM 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 DEN PM to confirm that the delivered material conforms to the mix design.

METHOD OF MEASUREMENT

153-5.1 Measurement. No separate measurement for payment shall be made for controlled low strength material (CLSM), unless otherwise indicated herein. CLSM shall be considered necessary and incidental to the work of this Contract.

BASIS OF PAYMENT

153-6.1 Payment. No payment will be made separately or directly for controlled low strength material (CLSM), unless otherwise indicated herein. CLSM shall be considered necessary and incidental to the work of this Contract.

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

ITEM P-159 CONCRETE AND ASPHALT CRUSHING

DESCRIPTION

159-1.1 This item shall consist of providing all equipment, labor, and utilities necessary to crush and stockpile concrete and asphalt rubble removed from the project at 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.

159-1.2 RELATED SECTIONS.

a. Section 014510 – Contractor Quality Control

b. Section 014525 – Material Testing Agency

c. DEN Concrete and Asphalt Recycle Yards – Standard Operating Procedures (current edition)

159-1.3 SUBMITTALS. (REFER TO SECTION 013300)

a. 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
¾ inch	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 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 the Contractor's 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.

MEASUREMENT AND PAYMENT

159-4.1 Concrete and asphalt crushing shall be measured, per ton. The quantity produced of each type of material will be directed by the DEN Project Manager or DEN Quality Assurance Recycling Yard Inspector. Payment will be made at the contract unit price, per ton This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item, including material hauling, pre-crushing of PCCP, pre-processing of CTB, steel removal, and dump fees.

Payment will be made under:

Item P-159-4.1	Crush PCCP Removals (Class 6) – per Ton
Item P-159-4.2	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

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. ASTM C595 Type IP, IS, IL cement may be used subject to DEN PM approval. Any cement used shall have a maximum sulfate resistance of 0.040% at 14 days (Percent expansion).

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 shall consist of the upper most 18-inches of select embankment as placed and paid for by Specification 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 Project Manager will approve the specific material used.

Bituminous Materials

Type and Grade	Specification	Application Temperature	
		Degrees F	Degrees C
Cutback Asphalt			
RC-70	ASTM D2028	120-160	50-70
RC-250	ASTM D2028	160-200	70-95
Emulsified Asphalt			
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 to provide a minimum 200 psi unconfined compressive strength at 5 days. The base material shall not exceed a maximum strength of 500 psi at 5 days.

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, 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, upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The DEN Project Manager must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be re-worked, 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 Project Manager. 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 Project Manager.

220-4.2 Weather limitations. The material shall not be mixed or placed while the atmospheric temperature is below 40°F or when conditions indicate that the temperature may fall below 40°F 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 sieve and a minimum of 80% passes a No. 4 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 Project Manager:

a. **Mixed-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 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. Tests shall be taken at not less than one test per 1,000 square yards of placement, or a minimum of 4 tests per day. The moisture content of the mixture at the start of compaction shall be within ±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. The material shall reach a minimum strength of 200 psi, before loading with heavy construction equipment. Damaged caused by the Contractor to the base materials, shall be repaired by the Contractor at Contractor expense.

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. 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 Project Manager.

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 Project Manager, 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, reshaped and re-compacted to grade, until the required smoothness and accuracy are obtained and approved by the DEN Project Manager. The Contractor shall perform all final smoothness and grade checks in the presence of the DEN Project Manager. 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, when tested with a 12-foot 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 straightedge, for the full length of each line on a 50-foot grid.

b. Grade. The grade and crown shall be measured on the P-501 PCCP panel joint corner grid (20' x 20') and shall be within +/-0.05 feet of the specified grade.

220-4.12 Acceptance sampling and testing. Cement Treated Soil 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 placed, 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 Contractor's laboratory shall perform all density tests in the presence of the DEN Project Manager and shall provide the test results upon completion to the DEN Project Manager for acceptance.

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 D1557. 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 in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch of the specified thickness, as determined by depth tests taken by the Contractor in the presence of the DEN Project Manager for each sublot. Where the thickness is deficient by more than 1/2-inch, 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 of completed and accepted base course.

220-5.2 Cement shall be measured by the ton.

BASIS OF PAYMENT

220-6.1 Payment shall be made at the contract unit price per square yard 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 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	Portland 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
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
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-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

Sieve Size	Design Range - Percentage by Weight
3/4 in	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-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 The quantity of CDOT Aggregate Base Course shall be the number of square yards compacted in place, completed and accepted.

304C-4.2 Separation geotextile shall be measured by the number of square yards of materials placed, accepted and 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 for CDOT Aggregate Base Course. This price shall be full compensation for furnishing this material and for all delivery, hauling, placing, and incorporation of this material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

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 - per square yard*

Item P-304C-5.2 Separation Geotextile – per square yard

* CDOT Aggregate Base Course, Class 6, may be obtained from the DEN recycle yard as a reduced or no cost option for the material only. The Contractor shall coordinate with DEN for material availability and scheduling.

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
AASHTO T 180	Standard Method of Test for Moisture-Density Relations of Soils

MATERIAL REQUIREMENTS

AASTHO M 147	Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses

END OF ITEM P-304C

ITEM P-307 CEMENT-TREATED PERMEABLE BASE COURSE (CTPB)

DESCRIPTION

307-1.1 This item shall consist of an open-graded drainable base composed of mineral aggregate, cement and water mixed in a central mixing plant and placed on a prepare subgrade or subbase course in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross sections shown in the plans.

MATERIALS

307-2.1 Aggregate. Coarse aggregate shall be crushed gravel or crushed stone and shall meet the gradation requirements of ASTM C33 Size 67. Fine aggregate shall consist of natural sand or manufactured sand meeting the requirements of ASTM C33. The aggregate shall meet the material requirements in the table below.

Aggregate Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate		
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[1]	10% maximum, by weight, for fraction retained on the ½ inch sieve and 10% maximum, by weight, for the fraction passing the 1/2-inch sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate		
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
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

[1] 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).

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 paragraph 307-2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

307-2.3 Cement. Cement shall conform to the requirements of ASTM C150, Type I/II ASTM C595 Type IP, IS, IL cement may be used subject to DEN PM approval.

The Contractor shall furnish vendor's certified test reports for cement shipped to the project.

307-2.4 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.

307-2.5 Admixtures. The use of any material to be added to the mixture shall be approved by the DEN PROJECT MANAGER.

307-2.6 Curing Material. Curing materials shall be a liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class B.

307-2.7 Bond Breaker. Bond breaker shall be placed in accordance with P-501.

307-2.8 Separation Geotextile. Not used.

COMPOSITION OF MIXTURE

307-3.1 Mix design. The Mix Design shall be composed of a mixture of aggregate, cement, and water meeting the following requirements:

Mix Design Requirements

Material or Test	Requirements	Standard	
7-day Compressive strength, psi	Between minimum 400 psi and maximum 800 psi	ASTM C31 and ASTM C39	Cylinders in accordance with ASTM C31 and test per ASTM C39
Coefficient of permeability (ft/day)	Between 500 to 1500 ft/day	AASHTO T215	
Water-Cement Ratio	Approx. 0.36		Cement content shall be adequate to hold the material together and meet strength requirements.
Coarse aggregate	Size #67	ASTM C33	
Fine aggregate	Approximately 300 to 400 pounds per cubic yard		As necessary to meet stability while maintaining permeability

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, if used. It shall also contain the 7-day and 14-day compressive strength test results and the results of the permeability tests. Data shall be provided to the DEN PROJECT MANAGER for 7-day breaks to serve as a basis for field testing requirements and comparison.

If the Contractor makes a change in aggregate sources or type of cement, or if cementitious additives are added or deleted from the mix, production of the drainable base course shall be stopped and a new mix design shall be submitted to the DEN PROJECT MANAGER for approval at the Contractor’s expense.

307-3.2 Submittals. At least 30 days prior to the placement of the CTPB, the Contractor shall submit certified test reports to the DEN PROJECT MANAGER for those materials proposed for use during construction, as well as the mix design information for the material. The certification shall show the specifications and tests for the material, the name of the testing laboratory, the date of the tests, and a statement that the materials comply with the applicable specifications. Tests shall be representative of the material to be used for the project. The submittal package shall include the following:

a. Sources 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
- Content of any additional cementitious materials or additives
- Compressive strength at 7 and 14 days.
- Coefficient of Permeability

No drainable base course material shall be placed until the submittal is accepted in writing by the DEN PROJECT MANAGER.

During production, the Contractor shall submit batch tickets for each delivered load.

CONSTRUCTION METHODS

307-4.1 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, 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 PROJECT MANAGER. Upon acceptance of the control strip by the DEN PROJECT MANAGER, 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 PROJECT MANAGER.

When additional effort beyond that provided by the paver is required to seat the aggregate, additional compaction shall be initiated within 30 minutes following the placing and striking-off operations. The actual rolling pattern and sequence shall be established during placement of the control strip and approved by the DEN PROJECT MANAGER. In areas inaccessible to the paver and roller, hand operated vibrator-plate compactors may be used to seat the aggregate.

The additional compaction, if required, shall be one to three passes of a self-propelled, steel-wheel static roller with weight between 5 and 12 tons. The roller shall be in good condition and shall be capable of reversing without backlash and of compacting the CTPB without undue displacement or excessive crushing of the aggregate.

The control strip CTPB layer shall be considered acceptable when aggregate is completely coated with cement paste with no evidence of crushing; the surface is firm, unyielding and stable under construction traffic; and the layer meets the field permeability per paragraph 307-3.1.

307-4.2 Weather limitations. The CTPB material shall not be mixed or placed while the air temperature is below 40°F or when conditions indicate that the temperature may fall below 35°F within 24 hours. The CTPB shall not be placed on frozen underlying courses or mixed when aggregate is frozen. The CTPB may not be placed when rainfall is occurring or where rain is imminent. Any CTPB material that has become excessively wet by rain during transport and/or placement will be rejected.

307-4.3 Equipment. All equipment necessary to mix, transport, place, compact, and finish the CTDB material shall be furnished by the Contractor and approved by the DEN PROJECT MANAGER. The equipment will be inspected by the DEN PROJECT MANAGER prior to the start of construction operations.

307-4.4 Preparation of the underlying course. The underlying course shall be checked and accepted by the DEN PROJECT MANAGER before placing operations begin. 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 lean concrete base course.

307-4.5 Mixing. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials. Free access to the plant must be provided to the DEN PROJECT MANAGER at all times for inspection of the plant's equipment and operation and for sampling the CTPB mixture and its components.

The mixers shall be examined daily by the Contractor and periodically by the DEN PROJECT MANAGER for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pick-up and throw-over blades shall be replaced as necessary to provide adequate mixing. Aggregate and cement may be proportioned either by weight or volume, and shall be mixed sufficiently to prevent the forming of cement balls when water is added. Batching weights shall be within a tolerance of 1% for cement and 2% for aggregates. The mixing time shall be that required to produce a uniform mixture of aggregate, cement, and water.

307-4.6 Hauling. The CTPB mixture shall be transported from the plant to the job site in trucks or other hauling equipment having beds that are smooth and clean. Truck bed covers shall be provided to protect the CTPB during transport from rain. CTPB material that becomes wet during transport will be rejected.

The elapsed time between the start of moist mixing and the time the CTPB is deposited in-place at the work site shall not exceed (a) 30 minutes when the CTPB is hauled in non-agitating trucks, or (b) 45 minutes when the CTPB is hauled in transit mixers. Re-tempering the CTPB material by adding water or by other means shall not be permitted.

307-4.7 Placing. The CTPB material shall be placed using a mechanical spreader or an asphalt paver. The CTPB shall be installed in a single 4-inch lift. The spreader or paver shall be capable of receiving, spreading, shaping, and placing a uniform, full-depth layer of material across the full width of the base in one pass. When two or more spreaders are required, they shall be operated so that spreading progresses along the full width of the base in a uniform manner, and the placement is no more than 1 hour apart.

304-4.8 Finishing. Shape the finished surface of the lean concrete base layer to the specified lines, grades, and cross-section.

307-4.9 Compaction. Immediately upon completion of the spreading operations, the CTPB material shall be compacted using the approved compaction equipment and roller pattern/sequence, as determined in the approved control strip. Sufficient rollers shall be furnished to handle the output of the plant. If the rolling pattern/sequence results in undue displacement of the surface, or causes crushing of the aggregate, work shall be stopped until the cause(s) can be determined and corrections are made.

A large asphalt paving machine with dual tamping bars may be used in lieu of rolling if approved during the control strip.

In all places not accessible to the rollers (or the alternative paving machine), the CTPB material shall be compacted with approved mechanical hand-operated tampers.

When additional effort beyond that provided by the paver is required to seat the aggregate, additional compaction shall be initiated within 30 minutes following the placing and striking-off operations

307-4.10 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.

All contact surfaces of previously constructed courses shall be cleaned of all dirt or other objectionable material and thoroughly moistened with water prior to placing new material.

307-4.11 Curing. The completed drainage layer shall be moist cured for a period of twelve hours followed by application of an impervious membrane curing compound in accordance with paragraph 307-2.6.

307-4.12 Surface Tolerance. The Contractor shall perform smoothness and grade checks daily. Any area not meeting smoothness and grade shall be corrected by the Contractor at the Contractor's expense. The Contractor shall provide smoothness and grade data to the DEN PROJECT MANAGER on a daily basis.

a. Smoothness. The finished surface shall not vary more than ±3/8-inch when tested with a 12-foot straightedge applied parallel with and at right angles to the centerline, and moved continuously forward at half the length of the 12-foot straightedge for the full length of each line on a 20-foot grid. The Contractor shall correct any high spots more than 3/8 inch in 12-foot with a grinding machine or remove and replace the material at the Contractor's expense. Any areas that have been ground shall have curing compound reapplied.

b. Grade. The grade shall be measured on the P-501 PCCP panel joint corner grid (20' x 20') and shall be within +/-0.05 feet of the specified grade. When the surface is more than 1/2 inch above the grade shown in the plans, the surface shall be corrected at the Contractor's expense to an elevation that falls within a tolerance of 1/4 inch.

307-4.13 Field Permeability. One test shall be performed by the Contractor in the presence of the DEN PROJECT MANAGER for 1,200 square yards. Test locations will be determined on a random basis in accordance with ASTM D3665. The permeability of the base will be determined in accordance with ASTM C1701.

307-4.14 Bond breaker. Prior to placing the overlaying concrete pavement, a bond breaker (P-501) shall be placed on the surface to prevent bonding.

307-4.15 Maintenance. The completed drainable base shall be maintained by the Contractor in a condition to meet all specification requirements until the pavement has been placed. Placement of the pavement shall be made within thirty (30) calendar days after placement of the drainage layer. The CTPB shall not be opened to traffic until specimens made in accordance with ASTM C31 and tested in accordance with ASTM C39 show that a 7-day compressive strength of 500 psi has been achieved.

MATERIAL ACCEPTANCE

307-5.1 Sampling and testing. All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the DEN PROJECT MANAGER for each 1,200 square yards. Sampling locations will be determined by the DEN PROJECT MANAGER on a random basis per ASTM D3665. The Contractor shall bear the cost of providing curing facilities for the strength specimens.

a. Compressive Strength. One sample CTPB will be taken for compressive strength for each 1,200 square yards, in accordance with ASTM C172. Two test cylinders will be made and cured from the sample per ASTM C31 and the 7-day compressive strength of each cylinder determined per ASTM C39. The compressive strength will be computed by averaging the two 7-day compressive strengths.

The Contractor shall provide for the initial curing of cylinders in accordance with ASTM C31 during the 24 hours after molding.

b. Thickness. Thickness will be determined by survey on a 20-foot by 20-foot grid.

c. Permeability. One test shall be performed by the Contractor in the presence of the DEN PROJECT MANAGER for 1,200 square yards. Test locations will be determined on a random basis in accordance with ASTM D3665. The permeability of the base will be determined in accordance with ASTM C1701.

Any materials not meeting the mix design requirement per standard ASTM T215 in Section 307-3.1 above shall be removed and replaced to the extents determined by DEN PROJECT MANAGER. The DEN PROJECT MANAGER may request additional testing for areas where materials are not meeting the acceptance criteria at no cost to the owner.

METHOD OF MEASUREMENT

307-6.1 Measurement. The quantity of CTPB to be paid for shall be the number of square yards of material placed, and accepted in the completed base course.

BASIS OF PAYMENT

307-7.1 Payment. Payment will be made at the contract unit price per square yard for CTPB as measured by DEN PROJECT MANAGER. This price shall be full compensation for furnishing all materials, for all preparation, mixing, placing, compacting curing and placement of overlaying bond breaker; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-307-7.1 Cement-Treated Permeable Base Course (CTPB) - 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 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 C150	Standard Specification for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ASTM C1701	Standard Test Method for Infiltration Rate of In Place Pervious Concrete
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM C174	Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C150	Standard Specification for Portland Cement
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

American Association of State Highway and Transportation Officials (AASHTO)

M288	Standard Specification for Geosynthetic Specification for Highway Applications
T215	Standard Method of Test for Permeability of Granular Soils (Constant Head),

END ITEM P-307

ITEM P-403 ASPHALT-MIX PAVEMENT BASE COURSE

DESCRIPTION

403-1.1 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 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

403-2.1 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 sieve. Fine aggregate is the material passing the No. 4 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 for surface, asphalt binder, and leveling course Loss: 50% maximum for base course	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 or more: Minimum 75% by weight of particles with at least two fractured faces and 85% with at least one fractured face[1]	ASTM D5821
	For pavements designed for aircraft gross weights less than 60,000 pounds: Minimum 50% by weight of particles with at least two fractured faces and 65% with at least one fractured face[1]	
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles with a value of 5:1 [2]	ASTM D4791
Bulk density of slag[3]	Weigh not less than 70 pounds per cubic foot	ASTM C29.

[1] 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.

[2] 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).

[3] 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 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
Natural Sand	15% maximum by weight of total aggregate	ASTM D1073

c. Sampling. ASTM D75 shall be used in sampling coarse and fine aggregate, and ASTM C183 shall be used in sampling mineral filler.

403-2.2 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

403-2.3 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[1]

[1] Follow procedure B on RTFO aged binder.

Required Grade Bump

Aircraft Gross Weight	High Temperature Adjustment to Asphalt Binder Grade	
	All Pavement Types	Pavement area with slow or stationary aircraft
≤ 12,500 lbs (5670 kg)	--	1 Grade

Aircraft Gross Weight	High Temperature Adjustment to Asphalt Binder Grade	
	All Pavement Types	Pavement area with slow or stationary aircraft
< 100,000 lbs (45360 kg)	1 Grade	2 Grade
≥ 100,000 lbs (45360 kg)	2 Grade	3 Grade

403-2.4 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

403-3.1 Composition of mixture. The asphalt plant mix shall be composed of a mixture of well-graded aggregate, filler and anti-strip agent if required, and asphalt binder. The several 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).

403-3.2 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 listed on the accrediting authority's website. 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.

403-3.3 Job-Mix Formula (JMF). No asphalt mixture shall be placed until an acceptable mix design has been submitted to the DEN PROJECT MANAGER for review and accepted in writing. The DEN PROJECT MANAGER'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 403-3.2. 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 a Marshall compactor in accordance with ASTM D6926.

Should a change in sources of materials be made, a new JMF must be submitted to the DEN PROJECT MANAGER for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the DEN PROJECT MANAGER 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 PROJECT MANAGER, will be borne by the Contractor.

The DEN PROJECT MANAGER 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 submitted 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 403-2.3. 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 403-2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 403-2.1 and 403-2.2.
- 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 course 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 (Marshall).
- Laboratory mixing and compaction temperatures.
- Supplier recommended mixing and compaction temperatures.
- Plot of the combined gradation on the 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

Test Property	Value	Test Method
Number of blows/gyrations	75	
Air voids (%)	3.5	ASTM D3203
Percent voids in mineral aggregate (VMA), minimum	See Table 2	ASTM D6995
TSR (1)	not less than 80 at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA)[2,3]	Less than 10 mm @ 4000 passes	AASHTO T340 at 250 psi hose pressure at 64°C test temperature

[1] Test specimens for TSR shall be compacted at 7 ± 1.0 % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

[2] 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

[3] Where APA not available, use Hamburg wheel test (AASHTO T 324) 10 mm@ 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)	100
3/4 inch (19.0 mm)	90-100
1/2 inch (12.5 mm)	68-88
3/8 inch (9.5 mm)	60-82
No. 4 (4.75 mm)	45-67
No. 8 (2.36 mm)	32-54
No. 16 (1.18 mm)	22-44
No. 30 (600 µm)	15-35
No. 50 (300 µm)	9-25
No. 100 (150 µm)	6-18
No. 200 (75 µm)	3-6
Voids in Mineral Aggregate (VMA)[1]	14
Asphalt Percent:	
Stone or gravel	4.5-7.0
Slag	5.0-7.5
Recommended Minimum Construction Lift Thickness	3-inches

[1]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.

403-3.4 Reclaimed Asphalt Pavement (RAP). RAP shall not be used.

403-3.5 Control strip. Full production shall not begin until an acceptable control strip has been constructed and accepted in writing by the DEN PROJECT MANAGER. 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 403-5.1, has been accepted, in writing, by the DEN PROJECT MANAGER.

The control strip will consist of at least 250 tons or 1/2 sublot, 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 403-4.13 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. 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 shall be evaluated for acceptance as a single lot in accordance with the acceptance criteria in paragraph 403-6.1 and 403-6.2. The control strip shall be divided into equal sublots. As a minimum, the control strip shall consist of three (3) sublots.

The control strip will be considered acceptable by the DEN PROJECT MANAGER if the gradation, asphalt content, and VMA are within the action limits specified in paragraph 403-5.5a; and Mat density greater than or equal to 94%, air voids 3.5% +/- 1%, and joint density greater than or equal to 92%.

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 403-8.1.

CONSTRUCTION METHODS

403-4.1 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 PROJECT MANAGER, if requested; however, all other requirements including compaction shall be met.

Table 4. Surface Temperature Limitations of Underlying Course

Mat Thickness	Base Temperature (Minimum)	
	Degrees F	Degrees C
3 inches or greater	40	4
Greater than 2 inches but less than 3 inches	45	7

403-4.2 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 PROJECT MANAGER, or DEN PROJECT MANAGER'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 PROJECT MANAGER

determines there is an excessive heat loss, segregation or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

403-4.3 Aggregate stockpile management. Aggregate stockpiles shall be constructed 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.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

403-4.4 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 PROJECT MANAGER. 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.

403-4.4.1 Material transfer vehicle (MTV). A material transfer vehicle is not required**.**

403-4.5 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 401-4.11.

403-4.6 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, 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.

403-4.6.1 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 also supply a qualified technician during all paving operations to calibrate the density gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the DEN PROJECT MANAGER upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

403-4.7 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 material to the mixer at a uniform temperature. The temperature of the 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 when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F when added to the aggregate.

403-4.8 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 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.

403-4.9 Preparation of asphalt mixture. The aggregates and the asphalt binder shall be weighed or metered and introduced into the mixer 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%.

403-4.10 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.

403-4.11 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 PROJECT MANAGER.

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 PROJECT MANAGER that every lot of each lift meets the grade tolerances of paragraph 401-6.2e 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 PROJECT MANAGER. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 10 feet 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 1 foot; 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 from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet. 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 PROJECT MANAGER 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 PROJECT MANAGER, and if it can be demonstrated in the laboratory, in the presence of the DEN PROJECT MANAGER, 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 PROJECT MANAGER, 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 long.

403-4.12 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**.**

403-4.13 Joints. The formation of all joints shall be made in such a manner as 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 are have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F; 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. An asphalt tack coat or other product approved by the DEN PROJECT MANAGER 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.

403-4.14 Saw-cut grooving. Saw-cut grooving is not required.

403-4.15 Diamond grinding. IF required, 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 wide. The saw blades shall be 1/8-inch wide with a minimum of 55 to 60 blades per 12 inches of cutting head width; grooves between 0.090 and 0.130 inches wide; and peaks and ridges approximately 1/32 inch 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 causes ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted.

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 of tack coat to all areas that have been subject to grinding.

403-4.16 Night-time Paving Requirements. The Contractor shall provide adequate lighting during any night-time construction. A lighting plan shall be submitted by the Contractor and approved by the DEN PROJECT MANAGER 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)

403-5.1 General. The Contractor shall develop a CQCP in accordance with Item C-100. No partial payment will be made for materials that are subject to specific QC requirements without an approved CQCP.

403-5.2 Contractor quality control (QC) facilities. The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The DEN PROJECT MANAGER shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The DEN PROJECT MANAGER 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.

403-5.3 Quality Control (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 lot from mechanical analysis of extracted aggregate in accordance with ASTM D5444 and 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 lot in accordance with ASTM C566.

d. Moisture content of asphalt. The moisture content of the asphalt shall be determined once per lot in accordance with AASHTO T329 or ASTM D1461.

e. Temperatures. Temperatures shall be checked, at least four times per lot, 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. 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 straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot straightedge approved by

the DEN PROJECT MANAGER. 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 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 will be taken perpendicular to the pavement centerline each 20 feet, or more often as determined by the DEN PROJECT MANAGER. 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 will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet; and at the third points of paving lanes when widths of paving lanes are 20 ft or greater. When placement abuts previously placed material the first measurement shall start with one half 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 shall be corrected with diamond grinding per paragraph 403-4.15 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 tack coat. 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 the placement of the first lift and then prior to 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, not-to-exceed 20 feet. 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 vertically and 0.1 feet laterally. The documentation will be provided by the Contractor to the DEN PROJECT MANAGER within 24 hours.

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 less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 403-4.15.

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 ½ inch and replacing with new material. Skin patching is not allowed.

403-5.4 Sampling. When directed by the DEN PROJECT MANAGER, 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.

403-5.5 Control charts. The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day shall be calculated and monitored by the QC laboratory.

Control charts shall be posted in a location satisfactory to the DEN PROJECT MANAGER 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 PROJECT MANAGER 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 JMF 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	±6%	±9%
1/2 inch	±6%	±9%
3/8 inch	±6%	±9%
No. 4	±6%	±9%
No. 16	±5%	±7.5%
No. 50	±3%	±4.5%
No. 200	±2%	±3%
Asphalt Content	±0.45%	±0.70%
Minimum VMA	-0.5%	-1.0%

b. Range. Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot 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
(n = 2)

Sieve	Suspension Limit
1/2 inch	11%
3/8 inch	11%
No. 4	11%
No. 16	9%
No. 50	6%

Sieve	Suspension Limit
No. 200	3.5%
Asphalt Content	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 sets of 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. **]**

403-5.6 Quality control (QC) reports. The Contractor shall maintain records and shall submit reports of QC activities daily , in accordance with the CQCP described in Item C-100.

MATERIAL ACCEPTANCE

403-6.1. Quality Assurance 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 PROJECT MANAGER 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 sublot basis.

(1) Sampling. Material from each sublot 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 sublot in accordance with ASTM D3203 for a set of three compacted specimens prepared in accordance with ASTM D6926.

d. In-place asphalt mat and joint density. Each sublot 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 inches 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 PROJECT MANAGER.

(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 PROJECT MANAGER 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 PROJECT MANAGER.

(3) Thickness. Thickness of each lift of surface course will be evaluated by the DEN PROJECT MANAGER 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 sublot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch 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 sublot 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 PROJECT MANAGER to circumscribe the deficient area.

(4) Mat density. One core shall be taken from each sublot. Core locations will be determined by the DEN PROJECT MANAGER in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot 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 sublot sample by the TMD for that sublot.

(5) Joint density. One core centered over the longitudinal joint shall be taken for each sublot which contains a longitudinal joint. Core locations will be determined by the DEN PROJECT MANAGER 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.

403-6.2 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, and grade**.**

b. Air voids. Acceptance of each lot of plant produced material for air voids will be based upon the average air void from the sublots. If the average air voids of the lot are equal to or greater than 2% and equal to or less than 5%, then the lot will be acceptable. If the average is below 2% or greater than 5%, the lot shall be removed and replaced at the Contractor’s expense.

c. Mat density. Acceptance of each lot of plant produced material for mat density will be based on the average of all of the densities taken from the sublots. If the average mat density of the lot so established equals or exceeds 94%, the lot will be acceptable. If the average mat density of the lot is below 94%, the lot shall be removed and replaced at the Contractor’s expense.

d. Joint density. Acceptance of each lot of plant produced asphalt for joint density will be based on the average of all of the joint densities taken from the sublots. If the average joint density of the lot so established equals or exceeds 92%, the lot will be acceptable. If the average joint density of the lot is less than 92%, the Contractor shall stop production and evaluate the method of compacting joints. Production may resume once the reason for poor compaction has been determined and appropriate measures have been taken to ensure proper compaction.

e. Grade. The final finished surface of the pavement of the completed project shall be surveyed to verify that the grade elevations and cross-sections shown on the plans do not deviate more than 1/2 inch vertically and 0.1 feet laterally. Acceptance shall be based on the P-501 PCCP panel joint corner grid (20’ x 20’), and all other areas/points deemed necessary for conformance, as determined by the DEN Project Manager.

Cross-sections of the pavement shall be taken at a minimum 20-foot longitudinal spacing and at all longitudinal grade breaks. Minimum cross-section grade points shall include grade at centerline and ± 10 feet of centerline.

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 sublot shall not be more than 95%.

The final surface shall be paved to grade-to-drain in all directions, including around structures, and shall not have any low-lying areas or deformities that preclude positive subsurface drainage across the asphalt surface. Final surface acceptance is subject to DEN PROJECT MANAGER approval.

403-6.3 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 PROJECT MANAGER. A retest will consist of all the sampling and testing procedures contained in paragraphs 403-6.1. Only one resampling per lot will be permitted.

(1) A redefined mat density will be calculated for the resampled lot. The number of tests used to calculate the redefined mat density 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 mat density for a resampled lot will be used to evaluate the acceptance of that lot in accordance with paragraph 403-6.2.

c. Outliers. Check for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and density determined using the remaining test values.

METHOD OF MEASUREMENT

403-7.1 Measurement. Plant mix asphalt mix pavement shall be measured by the number of tons of asphalt pavement used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.

BASIS OF PAYMENT

403-8.1 Payment. Payment for a lot of asphalt mixture meeting all acceptance criteria as specified in paragraph 403-6.2 shall be made at the contract unit price per ton for asphalt. 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.

Payment will be made under:

Item P-403-8.1 Asphalt Mixture Base 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-µm (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
ASTM C183	Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
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 Bituminous Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
ASTM D1074	Standard Test Method for Compressive Strength of Bituminous Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from 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 D4125	Standard Test Methods for Asphalt Content of Bituminous mixtures by the Nuclear Method
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
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5581	Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen)
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
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 Gyratory Compactor
ASTM D6926	Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
ASTM D6927	Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
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 E2133	Standard Test Method for Using a Rolling Inclinometer 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 T 340	Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA)

Asphalt Institute (AI)

MS-2	Mix Design Manual, 7th Edition
MS-26	Asphalt Binder Handbook AI State Binder Specification Database

FAA Orders

5300.1 Modifications to Agency Airport Design, Construction, and Equipment Standards

Federal Highway Administration (FHWA)

Long Term Pavement Performance Binder program

Software

FAARFIELD

END OF ITEM P-403

ITEM P-501 CEMENT CONCRETE PAVEMENT

DESCRIPTION

501-1.1 This work shall consist of pavement composed of cement concrete with 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% ±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.

Fine Aggregate Material Requirements		
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 ≤ FM ≤ 3.40	ASTM C136
Limits for Deleterious Substances in Fine Aggregate for Concrete		
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 3/4-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

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
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 sieve [1]	ASTM D4791
Bulk density of slag [2]	Weigh not less than 70 pounds per cubic foot	ASTM C29
D-cracking (Freeze-Thaw)[3]	Durability factor ≥ 95	ASTM C666

[1] 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).

[2] Only required if slag is specified.

[3] 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[1]
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert[2] (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	0.1[3]

[1] 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. The total of all deleterious materials increases up to 3.5%.

[2] Chert and aggregates with less than 2.4 specific gravity.

[3] 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 = (cumulative percent retained on the 3/8 in. sieve)(100) / (cumulative percent retained on the No. 8 sieve)

(3) The WF is defined as the percent passing the No. 8 sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds of cementitious material per cubic meter yard greater than 564 pounds per cubic yard.

(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 ±3 WF and ±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	*
1-1/2 inch	*
1 inch	*
3/4 inch	*
1/2 inch	*
3/8 inch	*
No. 4	*
No. 8	*
No. 16	*
No. 30	*
No. 50	*
No. 100	*

501-2.2 Cement. Cement shall conform to the requirements of ASTM C150 Type I/II. ASTM C595 Type IP, IS, IL cement may be used subject to DEN PM approval.

501-2.3 Cementitious materials.

a. Fly ash. Fly ash shall be Class F and 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.

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%.

d. Ultrafine fly ash and ultrafine pozzolan. UltraFine Fly Ash (UFFA) and UltraFine Pozzolan (UFP) shall conform to ASTM C618, Class F or N, and the following additional requirements:

(1) The strength activity index at 28 days of age shall be at least 95% of the control specimens.

(2) The average particle size shall not exceed 6 microns.

501-2.4 Joint seal. The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-604 or Item P-605, and shall be of the type specified in the plans.

501-2.5 Isolation joint filler. Pre-molded 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 PROJECT MANAGER. 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 PROJECT MANAGER.

501-2.6 Steel reinforcement. Reinforcing shall consist of bar mats, conforming to the requirements of ASTM A184 or A704. Panel reinforcement for PLB column structural support shall be epoxy coated.

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 PROJECT MANAGER 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, and shall have the approximate chemical form as shown below:

Lithium Admixture

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (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 less than 50% at the specified strengths. 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 PROJECT MANAGER for review and the DEN PROJECT MANAGER has taken appropriate action. The DEN PROJECT MANAGER'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 PROJECT MANAGER 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 56-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 for slip-form placement. For fixed-form placement, the slump shall not exceed 3 inches. For hand placement, the slump shall not exceed 4 inches.

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 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 PROJECT MANAGER for approval.

The DEN PROJECT MANAGER 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 PROJECT MANAGER 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 PROJECT MANAGER.

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 6.0%. 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 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 PROJECT MANAGER, 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 PROJECT MANAGER, 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 PROJECT MANAGER. 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 P-501-3.3. 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 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 5,000 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 PROJECT MANAGER. Hand screeding and float finishing may only be used on small irregular areas as allowed by the DEN PROJECT MANAGER.

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 PROJECT MANAGER.

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 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 PROJECT MANAGER. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch. 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 PROJECT MANAGER. 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. Re-tempering 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 PROJECT MANAGER, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

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 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. 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 , 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. 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 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 PROJECT MANAGER 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 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. 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 minimum flexural strength of 550 psi, based on the average of four field cured specimens per 4,000 square yards 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 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.

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. 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 segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch, and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch. (The total free edge of 500 feet 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 of paving lane originally constructed as a separate lane will have 1,000 feet of free edge, 500 feet 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 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 PROJECT MANAGER.

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 PROJECT MANAGER.

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 PROJECT MANAGER.

If a lack of consolidation of the hardened concrete is suspected by the DEN PROJECT MANAGER, referee testing may be required. Referee testing of hardened concrete will be performed by the Contractor by cutting cores from the finished pavement after a minimum of 24 hours curing. The DEN PROJECT MANAGER shall visually examine the cores for evidence of lack of consolidation. Density determinations will be made by the Contractor, 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 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 from their designated position and shall be true to line with not more than 1/4-inch variation in 10 feet. The surface across the joints shall be tested with a 12-foot straightedge as the joints are finished and any irregularities in excess of 1/4 inch 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 pre-molded 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 PROJECT MANAGER. 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 ±3/4 inch. The vertical location on the face of the slab shall be within a tolerance of ±1/2 inch. The method used to install dowels shall ensure that the horizontal and vertical alignment will not be greater than 1/4 inch per feet, 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.

Dowels and tie bars shall not be placed closer than 0.6 times the dowel bar or tie bar length to the planned joint line. If the last regularly spaced longitudinal dowel and/or tie bar is closer than that dimension, it shall be moved away from the joint to a location 0.6 times the dowel bar and/or tie bar length, but not closer than 6 inches to its nearest neighbor.

(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 PROJECT MANAGER.

(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 ±1/2 inch 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 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 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 PROJECT MANAGER, may be used in accordance with the manufacturer’s 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 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 PROJECT MANAGER's approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds 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 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 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 directed by the DEN PROJECT MANAGER 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 in depth. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the DEN PROJECT MANAGER.

a. Brush or broom finish. Shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface.

b. Burlap drag finish. Burlap, 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.

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 to not more than 150 square feet. 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 PROJECT MANAGER, 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 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 PROJECT MANAGER.

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 PROJECT MANAGER. Honeycombed areas that extend into the slab greater than a depth of 1 inch 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 or P-605, as indicated on the plans.

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 PROJECT MANAGER. 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 PROJECT MANAGER.

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 550 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 PROJECT MANAGER, 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 PROJECT MANAGER 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 be have a diameter of 2 inches to 4 inches, 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 PROJECT MANAGER 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 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 PROJECT MANAGER. 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 PROJECT MANAGER. 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 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, ±1/16 inch, and to a width of 5/8 inch, ±1/8 inch. 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 PROJECT MANAGER.

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 PROJECT MANAGER 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. (New or existing pavement)

(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 outside the spalled area and to a depth of at least 2 inches. Saw cuts shall be straight lines forming rectangular areas surrounding the spalled area.

ii. Remove unsound concrete and at least 1/2 inch 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 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 wide. The saw blades shall be 1/8-inch wide with sufficient number of flush cut blades that create grooves between 0.090 and 0.130 inches wide; and peaks and ridges approximately 1/32 inch 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 PROJECT MANAGER 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 PROJECT MANAGER shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The DEN PROJECT MANAGER 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 PROJECT MANAGER as part of the CQCP.

The DEN PROJECT MANAGER 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 PROJECT MANAGER, and if it can be demonstrated in the laboratory, in the presence of the DEN PROJECT MANAGER, 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 sublot. 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 sublot. 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 sublot. 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 straightedge, a rolling inclinometer meeting the requirements of ASTM E2133, or rolling external reference device that can simulate a 12-foot straightedge approved by the DEN PROJECT MANAGER. 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 or more often as determined by the DEN PROJECT MANAGER. 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; and at the third points of paving lanes when widths of paving lanes are 20 ft or greater.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch 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 grade-lines (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 grade-line elevations and cross-sections shown on the plans by more than 1/2 inch vertically and 0.1 feet laterally. The documentation will be provided by the Contractor to the DEN PROJECT MANAGER within 48 hours.

Areas with humps or depression that 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 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 PROJECT MANAGER 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 PROJECT MANAGER 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[1]

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Gradation[2]	*[3]	*[3]
Coarseness Factor (CF)	±3.5	±5
Workability Factor (WF)	±2	±3
Slump	+0.5 to -1 inch	+1 to -1.5 inch
Air Content	±1.5%	±2.0%

[1] Control charts shall developed and maintained for each control parameter indicated.

[2] Control charts shall be developed and maintained for each sieve size.

[3] 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.

e. 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 PROJECT MANAGER. 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, 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 PROJECT MANAGER 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**,** or as determined by the DEN PROJECT MANAGER for low production days. Each lot will be divided into approximately four equal sublots. 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 sublot from the concrete delivered to the job site. Sampling locations will be determined by the DEN PROJECT MANAGER 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 PROJECT MANAGER will be responsible for the casting, initial curing, transportation, and curing of specimens in accordance with ASTM C31. Two (2) 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 sublot will be computed by averaging the results of the two test specimens representing that sublot.

(3) Acceptance. Acceptance of pavement for strength will be determined by the DEN PROJECT MANAGER 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 sublot in the presence of the DEN PROJECT MANAGER. Sampling locations will be determined by the DEN PROJECT MANAGER 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 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 PROJECT MANAGER within one day after sampling.

(2) Testing. The thickness of the cores will be determined by the DEN PROJECT MANAGER 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 PROJECT MANAGER 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

(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. Acceptance for profilograph smoothness will be based on the criteria contained in paragraph 501-6.6b(4).

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)

Strength	0.93 × strength specified in paragraph 501-3.3
Thickness	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 grade-line elevations and cross-sections shown on the plans by more than 1/2 inch vertically or 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 sublot shall reduced by 5% and not be more than 95%. The final surface shall be paved to grade-to-drain in all directions, including around structures, and shall not have any low-lying areas or deformities that preclude positive subsurface drainage across the concrete surface. Final surface acceptance is subject to DEN PROJECT MANAGER approval.

(4) Profilograph roughness for QA Acceptance. The final profilograph shall be the full length of the project to facilitate testing of roughness between lots. The Contractor, in the presence of the DEN PROJECT MANAGER, shall perform a profilograph roughness test on the completed project with a profilograph meeting the requirements of ASTM E1274 or a Class I inertial profiler meeting ASTM E950. Data and results shall be provided within 48 hrs of profilograph roughness tests.

The pavement shall have an average profile index less than 15 inches per mile per 1/10 mile. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate “must grind” bumps and the Profile Index for the pavement using a 0.2-inch blanking band. The bump template must span one inch with an offset of 0.4 inches. The profilograph must be calibrated prior to use and operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch equals 25 feet and a vertical scale of one inch equals one inch.

Profilograph shall be performed one foot right and left of project centerline and 15 feet right and left of project centerline. Any areas that indicate “must grind” shall be corrected with diamond grinding per paragraph 501-4.19f or by removing and replacing full depth of surface course. as directed by the DEN PROJECT MANAGER. Where corrections are necessary, a second profilograph run shall be performed to verify that the corrections produced an average profile index of 15 inches per mile per 1/10 mile or less.

(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 sublot, payment will be reduced 5%.

METHOD OF MEASUREMENT

501-7.1 Portland Cement Concrete Pavement shall be measured by the number of square yards of plain or reinforced pavement as specified in-place, completed and accepted by the DEN PROJECT MANAGER.

501-7.2 Bond Breaker Fabric shall be measured by the number of square yards completed and accepted in place as specified, or as directed by the DEN PROJECT MANAGER.

501-7.3 Crack Repair shall be measured by the number of linear feet completed and accepted in place as specified, or as directed by the DEN PROJECT MANAGER.

501-7.4 Spall Repair of Existing PCCP Pavement shall be measured by the number of square feet completed and accepted in place as specified, or as directed by the DEN PROJECT MANAGER.

501-7.5 Route and Seal PCCP Joints shall be measured by the number of linear feet completed and accepted in place as specified, or as directed by the DEN PROJECT MANAGER.

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, smoothness, 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 (square meters) of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment for crack repair, spall repair, and reseal joints of existing PCC pavement will be paid per square foot or linear foot for areas specified on the Concrete Maintenance Plans for existing concrete to remain in place.

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[1]

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[2]

[1] 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.

[2] 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 sublot.

d. Profilograph Roughness. The Contractor will receive full payment when the profilograph average profile index is in accordance with paragraph 501-6.6b(4). When the final average profile index for the entire length of pavement does not exceed 15 inches per mile per 1/10 mile, payment will be made at the contract unit price for the completed pavement.

Payment will be made under:

Item P-501-8.1	Portland Cement Concrete Pavement - 12” Reinforced - per square yard
Item P-501-8.2	Portland Cement Concrete Pavement - 17” Plain - per square yard
Item P-501-8.3	Portland Cement Concrete Pavement - 17” Reinforced - per square yard
Item P-501-8.4	Portland Cement Concrete Pavement - 21” Plain - per square yard
Item P-501-8.5	Portland Cement Concrete Pavement - 21” Reinforced - per square yard
Item P-501-8.6	Bondbreaker Fabric – per square yard
Item P-501-8.7	Crack Repair of Existing PCC Pavement – per linear foot
Item P-501-8.8	Spall Repair of Existing PCC Pavement – per square foot
Item P-501-8.9	Reseal Joints of Existing PCC Pavement – 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
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
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-µm (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)
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)
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 Inclinometer 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, 16th 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 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 or above; the temperature has not been below 35°F 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 or seven feet 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 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)	.0.06-0.12 (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 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 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

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 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 or above; the temperature has not been below 35°F 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 or seven feet 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 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)	.0.06-0.12 (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 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 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

ITEM P-604A PRE-FORMED 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^3
Water Absorption	ASTM D3575 Suffix L	0.02 lbs/ft^2
Weather/Deterioration	AASHTO T42	No Deterioration

Acceptable Metal Expansion Joint Manufacturers:

Product Name	Manufacturer
SSCM2 with A2R-400 Sealing Element	D.S. Brown

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 ¾ 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, direct, 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.

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

604A-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.

604A-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

604A-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.

604A-6.2 Metal expansion joint shall be measures per linear foot.

BASIS OF PAYMENT

604A-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. Payment shall be made for the metal expansion joint per linear foot and any repairs deemed necessary by the DEN project manager.

604A-7.2 Metal Expansion Joint and Metal Expansion Joint Repairs payment will be made at the contract unit price per linear foot. These prices shall be full compensation for furnishing all materials and for all preparation, delivery and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-604A-7.1 Metal Expansion Joint Repair – per linear foot

Item P-604A-7.2 Metal Expansion Joint – per linear foot

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 joints between concrete and concrete and ASTM D6690-Type II for joints between, asphalt and concrete.

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% ± 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°F 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 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°F 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. Tractor-mounted routing tool. Not used.

b. 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.

c. Sandblasting equipment. The Contractor must demonstrate sandblasting equipment including the air compressor, hose, guide and nozzle size, under job conditions, before approval in accordance with paragraph 605-3.3. The Contractor shall demonstrate, in the presence of the DEN PM, that the method cleans the joint and does not damage the joint.

d. Water-blasting equipment. The Contractor must demonstrate water-blasting equipment including the pumps, hose, guide and nozzle size, under job conditions, before approval in accordance with paragraph 605-3.3. The Contractor shall demonstrate, in the presence of the DEN PM, that the method cleans the joint and does not damage the joint.

e. 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.

f. Hot-poured sealing equipment. The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

g. 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, concrete saw, or water-blaster as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch 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 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 ±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.

METHOD OF MEASUREMENT

605-4.1 Joint sealing material shall not be measured separately but shall be considered incidental to the applicable work items.

BASIS OF PAYMENT

605-5.1 Payment for joint sealing material shall not be made separately but shall be considered incidental to the applicable work items.

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

END ITEM P-605

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 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	467 or 4 and 67
1 inch	57
3/4 inch	67
1/2 inch	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. ASTM C595 Type IP, IS, IL cement may be used subject to DEN PM approval. Any cement used shall have a maximum sulfate resistance of 0.040% at 14 days (Percent expansion).

610-2.5 Cementitious materials.

a. Fly ash. Fly ash shall be Class F and 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 Pre-molded joint material. Pre-molded 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 A184. Structural steel reinforcement (deformed bar) shall be as outlined in the plans and shall be epoxy coated (green bar).

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 of:

a. 3000 psi for concrete encased lighting ducts and light cans under P-401 asphalt or P-501 concrete paving, within econocrete/CTB or ATPB, and elsewhere as noted in the plans and specifications.

b. 4,000 psi for structural concrete and elsewhere as noted in the plans and specifications

c. 1,200 psi at 7 days for repair of cement treated base course

in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 470 pounds of cementitious material per cubic yard. The 3,000 psi and 1,200 psi mix designs need not contain the full 470 pounds of cementitious material, but shall contain the minimum cement content required to achieve the specified strength. The water cementitious ratio shall not exceed 0.45 by weight. The air content of the concrete shall be 5% +/- 1.2% as determined by ASTM C231 and shall have a slump of not more than 4 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 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 nor more than 100°F. 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.

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. 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, 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 85ºF, 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.

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 Concrete for utility structures shall be considered incidental and no separate measurement shall be made.

610-5.2 Cement-Treated Base (CTB) repair shall be measured per square yard including existing cement-treated base milling and structural concrete installation.

610-5. Concrete for Islands, Curbs, Median, and Base Protection Repairs shall be measured per linear foot or each as defined below.

BASIS OF PAYMENT

610-6.1 Concrete for utility structures shall be considered incidental and no separate payment shall be made.

610-6.2 Payment shall be made at the contract unit price per square yard for cement-treated base repair. These prices shall be full compensation for furnishing all materials and for all preparation, delivery and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

610-6.2 Payment shall be made at the contract unit price per linear foot or each as defined below concrete islands, curb, median, and column base protection. These prices shall be full compensation for furnishing all materials and for all preparation, delivery and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item complete in-place and accepted by the DEN PMT.

Payment will be made under:

Item P-610-6.1	Cement-Treated Base Repair - per square yard
Item P-610-6.2	Concrete Island (7-Inch) (Fire Hydrant) - per square yard
Item P-610-6.3	Concrete Island (8-Inch) (Gate House) - per square yard
Item P-610-6.4	Concrete Island (8-Inch) (A46 EFSO Base) - per square yard
Item P-610-6.5	Concrete Column Base Protection – per each
Item P-610-6.6	Concrete Curb Stop – 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 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 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
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 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[1]				Glass Beads[2]	
Type	**Color**	**Fed Std. 595 Number**	**Application Rate Maximum**	**Type**	**Application Rate Minimum**
* Waterborne Type II	*White	*37925	*115 ft^2/gal	* Type I, Gradation A	*7 lb/gal
* Waterborne Type II	* Yellow	*33538	*115 ft^2/gal	* Type I, Gradation A	*7 lb/gal
Methacrylate	Yellow	33538	45 ft^2/gal	Type I, Gradation A	15 lb/gal
Waterborne Type II	Pink	1 part 31136 to 2 parts 37925	115 ft^2/gal	Type I, Gradation A	5 lb/gal
Methacrylate	Pink	1 part 31136 to 2 parts 37925	45 ft^2/gal	Type I, Gradation A	13 lb/gal
Waterborne Type II	Black	37038	115 ft^2/gal	No Beads	No Beads
Methacrylate	Black	37038	45 ft^2/gal	No Beads	No Beads

[1] See paragraph 620-2.2a

[2] 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 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 to four 3 × 6-inch 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, and four (4) hours condensate exposure at 104°F.

(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. 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. Five liters (17.5 lb) 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 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, 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 contaminates 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 rotary grinding, 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. The locations of markings to receive silica sand 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 in 50 feet, and marking dimensions and spacing shall be within the following tolerances:

Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch or less	±1/2 inch
greater than 36 inch to 6 feet	±1 inch
greater than 6 feet to 60 feet	±2 inch
greater than 60 feet	±3 inch

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. 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^2/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[1]	100	75	10

[1] '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 shall be measured by the number of square feet of painting applied and accepted by the DEN PM.

620-4.2 Removal of pavement marking shall be measured per square foot, to include all incidentals including removal and cleanup of the impacted area.

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 Remove Pavement Marking shall be made at the contract price for the number of square feet of marking removed.

Payment will be made under:

Item P-620-5.1 Airfield Pavement Markings - Permanent – per square foot

Item P-620-5.2 Airfield Pavement Markings - Temporary – per square foot

Item P-620-5.3 Remove Pavement Markings – per square 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 D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1652	Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D7585	Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments
ASTM E303	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
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

Commercial Item Description

A-A-2886B	Paint, Traffic, Solvent Based

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

ITEM B-101 INSTALLATION OF BOLLARDS

DESCRIPTION

101-1.1 This work consists of the installation of bollards in accordance with these specifications and in conformity with the lines and grades shown on the plans or as established.

MATERIALS

101-2.1 BOLLARDS. Pipe for the bollards shall be 6-inch diameter of the length shown and shall conform to ASTM A53 Pipe, Steel, Black, and Hot-dipped Zinc Coated (Galvanized) Welded and Seamless.

101-2.2 PLASTIC COVER. Plastic covers shall be a safety yellow plastic cover as manufactured by Cal Pipe Mfg. or approved equal. Plastic covers shall match other bollards around the concourses.

101-2.3 CONCRETE. Concrete shall conform to Item P-610.

CONSTRUCTION METHODS

101-3.1 GENERAL. The Contractor will be required to furnish and install all equipment and materials necessary to complete the bollards. Locations of the various components shall be as shown on the drawings and/or as directed by the DEN Project Manager.

101-3.2 BOLLARD INSTALLATION. Bollards shall be 6-inch diameter steel pipe filled with concrete. Installed bollards shall be either bolted and anchored into existing pavement or installed within full-depth pavement sections. Anchor rods for surface-mounted bollards shall be 3/4-inch diameter x 6-inch bolts or approved equal embedded to a minimum depth of 6 inches. Existing pavement shall be core drilled at each bolt location for installation of the surface-mounted bollard. Posts shall be 36 inches above pavement grade. Install plastic covers on bollards to match other bollards around the concourse areas. Posts installed within full-depth pavement sections shall be 36 inches above pavement grade with a minimum of 36 inches embedment. 1/2-inch expansion joint material shall be installed between the new bollard and full-depth pavement section.

Bollards shall not be installed within 12” of any PCC joint, stair foundations, or pedestrian loading bridge structures. In addition, the Contractor shall follow any working space requirements defined on ground service equipment on the apron.

Prior to installation of any bollards, the Contractor shall schedule a pre-installation bollard walk with DEN Project Manager, DEN QA, and the DOR. This walk will determine the final locations of the bollards to be installed due to any changes to the final site layout during construction.

METHOD OF MEASUREMENT

101-4.1 MEASUREMENT. Installed bollards shall be measured per each, installed, primed, painted, and sleeved, in accordance with the plans and specifications and accepted by the DEN Project Manager.

BASIS OF PAYMENT

101-5.1 PAYMENT. Payment for accepted installed bollards will be made at the contract unit price per each performed in accordance with the plans and specifications. The furnishing and installation of bollards shall include any excavation, drilling, anchoring, concrete, and all other work and material necessary to complete the items.

Item B-101-5.1	Install Bollard (Surface Mounted) - per each
Item B-101-5.2	Install Bollard (Cored) - per each

MATERIAL REQUIREMENTS

ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

END OF ITEM B-101

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 non-combustible 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, as applicable:

AASHTO) M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
ASTM A761	Standard Specification for Corrugated Structural Steel Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
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 Item 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 pre-coated 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 Solvent Cement. Solvent Cement shall conform to the requirements of Section 221316-2.2(I).

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 Pre-cast box culverts. Not used.

701-2.10 Pre-cast concrete pipe. Pre-cast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association QCast Plant Certification program.

701-2.11 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 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 or 1/2 inch 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.

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.

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.

701-3.2 Bedding. The pipe bedding shall conform to the requirements of P-152. The bedding surface for the pipe shall provide a foundation of uniform density to support the pipe throughout its entire length.

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 bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows: 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. For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 sieve. For all other areas, no more than 50% of the material shall pass the No. 200 sieve. The bedding shall have a thickness of at least 6 inches 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. For underdrain applications, the pipe bedding shall be in accordance with Item D-705. Flexible pipe.

For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows: bedding material shall be in accordance with Item P-153.

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. Concrete pipe joints shall be sealed with butyl mastic meeting ASTM C990 or mortar when soil tight joints are required. Joints shall be thoroughly wetted before applying mortar or grout.

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 and fiberglass 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 on each side of the pipe and shall be brought up one foot 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 and shall be brought up evenly on each side of the pipe to one foot 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 re-laid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be place and compacted in layers as required to achieve compaction to 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.

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 of 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 PURe or DE NEEF® Flex SLV PURe , 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 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. All fittings shall be included in the footage as typical pipe sections in the pipe being measured.

BASIS OF PAYMENT

701-5.0 These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, bedding, backfill, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

701-5.1 Payment will be made at the contract unit price per linear foot for each class, type and size of pipe, installed and accepted by the DEN PM.

Payment will be made under:

Item 701-5.1	Remove and Replace 12” SDG Drain Pipe - per linear foot
Item 701-5.2	Remove and Replace 15” SDG Drain Pipe - per linear foot
Item 701-5.3	Remove and Replace 6” SAG Pipe - per linear foot
Item 701-5.4	Install 4" PVC Drain Pipe - per linear foot
Item 701-5.5	Install 18” RCP (Class V) – 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.

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
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
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

ITEM D-702 SLOTTED DRAINS

DESCRIPTION

702-1.1 This item shall consist of the construction of steel slotted drains or cast iron slotted vane 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 for approval, prior to procuring trench drain systems for installation.

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 as follows, depending upon the location within the airside pavement:

a. In aircraft movement areas, the trench drain system shall be rated for an aircraft wheel load of 200,000 pounds with a maximum tire pressure of 250 psi.

b. In ground service equipment (GSE) movement areas, the trench drain system shall be rated, at a minimum, for HS-20 loading. If aircraft tug vehicles utilize the pavement, it is recommended that they be rated as depicted under paragraph A above; same as aircraft.

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.

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 A 184. 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 contraction joints shall conform to the requirements of P-604B Poly-chloroprene Compression Joint Seals.

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 of 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 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:

Installation Location	Product Name	Manufacturer
Aircraft Areas	MHD-A	ABT, Inc.
	Perma-Trench	Zurn
GSE Areas	Polydrain	ABT, Inc.

Modular trench drain systems shall be one as listed above or approved equal. Requests for approval of equal or equivalent trench systems 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 warranty on the materials furnished for 5 years from the date of Substantial Completion. The Contractor shall provide a warranty 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 Project Manager 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 15 seconds in anyone location. Necessary hand spreading of concrete shall be done with shovels, and not with rakes or vibrators.

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 Portland Cement Concrete Pavement.

702-3.7 Sealing Joints. The joints in the trench drain concrete slab shall be sealed in accordance with Item P-605 Joint Sealing Filler.

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 or 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 will be made at the contract unit price per linear foot for complete, in-place, and approved trench drain. This price shall fully compensate the Contractor for furnishing all materials; including trench drain channels, frames and grates; outlet pipes; reinforcing steel and concrete backfill; for all preparation, excavation, backfill, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 702-5.1	Install Trench Drain – per linear foot
Item 702-5.2	Install 10” SCH 80 Galvanized Pipe – 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 A 184	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 D 1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
ASTM D 1752	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

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.

American Association of State Highway and Transportation Officials (AASHTO) M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
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
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.

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	100
1 inch	90 - 100
3/8 inch	25 - 60
No. 4	5 - 40
No. 8	0 - 20
No. 16	*
No. 50	*
No. 100	*

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^{-1}	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 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. 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 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 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 for the pipe.

705-3.3 Laying and installing pipe.

a. Concrete pipe. Not used

b. Metal pipe. Not used.

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 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. Re-tempering of mortar shall not be permitted.

705-3.5 Joints in concrete pipe. Not used.

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 over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches 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 in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches. 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 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, measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches 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 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, filter fabric, excavation, backfill and any other incidentals required to install the underdrain trench shall be included in the footage as incidental the pipeline being measured .

705-4.2 Underdrain cleanouts shall be measured per each, to include all incidentals required to complete the item.

BASIS OF PAYMENT

705-5.1 Payment will be made at the contract unit price per linear foot for pipe underdrains of the type, class, and size designated, installed and accepted by the DEN PM.

705-5.2 Payment will be made at the contract unit price per each for underdrain cleanouts, installed completed and approved by the DEN PM**.**

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	Install 6” Perforated Underdrain Pipe – per linear foot
Item D-705-5.2	Install 6” Non-Perforated Underdrain Pipe – per linear foot
Item D-705-5.3	Install 6” Underdrain Cleanout – per each
Item D-705-5.4	Install 6" Underdrain Cleanout (WYE) – per each
Item D-705-5.5	Install 4" SDG Cleanout – 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 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

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-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 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 nor more than 48 inches. 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. Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

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 standard requirements.

751-2.7 Steps. Steps or ladders shall not be installed in any GARDI structure, including: vaults, manholes, handholes, storm structures, sanitary structures, jet-fuel structures, EFSO structures, electrical structures, etc., unless directed otherwise by the DEN PM. Contractor shall confirm with the DEN PM which structures are to receive steps/ladders, prior to fabrication and delivery to the site.

751-2.8 Precast inlet structures. Manufactured in accordance with and conforming to ASTM C913.

751-2.9 Reinforcing Steel. All reinforcing steel shall conform to ASTM A615, Grade 60. Type A1 reinforcing steel shall be epoxy coated (green bar).

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.

Sanitary manholes will require the installation of waterstop gaskets, flexible rubber wedge-type gasket, or approved equal for all pipe connections in accordance with the City and County of Denver Wastewater Standard Details, current edition.

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.

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.

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.

Sanitary manholes will require the installation of waterstop gaskets, flexible rubber wedge-type gasket, or approved equal for all pipe connections in accordance with the City and County of Denver Wastewater Standard Details, current edition.

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 GARDI structure, including: vaults, manholes, handholes, storm structures, sanitary structures, jet-fuel structures, EFSO structures, electrical structures, etc., unless directed otherwise by the DEN PM. Contractor shall confirm with the DEN PM which structures are to receive steps/ladders, prior to fabrication and delivery to the site.

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 Waterstop. Hydrophilic waterstop shall be installed in sanitary structures, in accordance with the City and County of Denver Wastewater Standard Details, current edition. The water stop shall be a pre-formed rubber strip with stainless steel net, which expands when exposed to moisture, and shall be NSF 61 certified for potable water. Waterstop shall be installed in accordance with manufacturer's recommendations.

751-3.11 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.

751-3.10 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. Epoxy Lining Applicator's Qualifications: Minimum 5 years' experience in application of products to be used. Manufacturer's Certifications: Applicator has been trained and approved in the handling, mixing and application of the products to be used. Equipment to be used for applying the product has been approved and the applicator personnel have been trained and certified for proper use of the equipment. Five (5) recent references of applicator (projects of similar size and scope) indicating successful application within the past 10 years.

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, catch basins, inlets, and inspection holes shall be measured by the unit, completed 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	Modify and Partially Replace DIW Inlet – per each
Item D-751-5.2	Install Sanitary Manhole (SAG) – per each
Item D-751-5.3	Adjust Water Vault (DWD) – per each
Item D-751-5.4	Install Storm Manhole (SDG) – per each
Item D-751-5.5	Install DIW Inlet – per each
Item D-751-5.6	Install DIW 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.
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

SECTION 024101

FUEL PIPING REMOVAL

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Requirements for the removal of jet fuel piping systems.
2. Requirements for the cleaning and disposal of jet fuel piping systems.

1.02 REFERENCES

A. American Petroleum Institute:

1. Bulletin 2201 Procedures for Welding or Hot Tapping on Equipment Containing Flammables.
2. Bulletin 2209 Pipe Plugging Practices.

B. National Fire Protection Association (NFPA):

1. NFPA 30 – Flammable and Combustible Liquids Code (2008 Edition).

C. Occupational Safety and Health Administration (OSHA):

1. 29 CFR Part 1910 - Occupational Safety and Health Standards.
2. 29 CFR Part 1926 - Occupational Safety and Health Standards - Excavations.

1.03 SUBMITTALS

A. Submit as specified in Division 1.

B. Contractor shall provide Owner with a written certificate of piping disposal stating that the piping systems have been disposed of in accordance with applicable federal, state, and local regulations.

C. The Contractor’s Health and Safety Plan shall address all aspects of fuel system removals.

1.04 JOB CONDITIONS

A. Precautions for piping to be demolished: Contractor shall take all necessary precautions and conform to all applicable laws, regulations, and local ordinances, including OSHA and EPA.

B. Owner and Others will continuously occupy adjacent areas. Conduct piping removal work in a manner that will minimize disruption of normal operations. Provide a minimum of 72-hour advance notice to Owner of activities which will impact normal operations.

C. Shutdown of Owner's or Others' operating facilities to perform the work shall be closely coordinated well in advance so alternate arrangements can be made. Sequencing of new fuel system construction may require completion of new fuel line segments prior to removal of existing, active fuel system, and piping. In the event of conflict, Owner shall have control over the timing and schedules of such shutdowns.

D. Barriers shall be placed at the work site and around excavations as required to prevent unauthorized entry and to protect work and existing facilities from construction operations.

1.05 QUALITY ASSURANCE

A. Contractor shall certify that employees and subcontractors responsible for piping removal have been properly trained in the following:

1. Use of equipment and procedures for flammable atmosphere testing, gas purging and cutting of previously in-service petroleum piping.
2. Handling and disposal of aviation fuels and their by-products.
3. Identification and procedures for handling ignition sources and other safety hazards.
4. All applicable safety rules and regulations.

B. Work shall be performed in accordance with Contractor's Health and Safety Plan.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 GENERAL

A. The demolition of fuel piping as specified and indicated shall be in strict accordance with all federal, state, and local regulations and codes including, but not limited to, the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), LAWA, and other applicable federal, state, and local codes. Other recommended practices and standards pertaining to this type of demolition and removal include the American Petroleum Institute (API) Bulletins and National Fire Protection Association (NFPA) codes.

B. Piping demolition/removal shall include underground and aboveground single wall, coated, carbon steel piping. All associated appurtenances such as high point vents, low point drains, hydrant pits, isolation valve pits, cathodic protection test stations, casing pipes, and concrete encasement that are encountered with the fuel pipe demolition limits shall also be removed.

3.02 WASTE MATERIALS

A. All materials classified as hazardous or special waste shall be disposed of by methods approved by the Owner and system operator prior to removal. The disposal facility shall be at Contractor’s option, subject to approval by Owner.

B. Hazardous or Special Wastes Removed from Piping:

1. All fuel shall be removed by the Contractor from the piping and properly disposed.
2. The Contractor should assume that all existing abandoned fuel piping contains fuel and slurry that is considered hazardous.

C. Contractor shall be responsible for any costs such as sampling, analysis, removal and disposal resulting from contamination or spillage caused by Contractor. The laboratory to be used and tests to be performed will be approved by the Owner.

3.03 SYSTEM PREPARATION

A. Piping preparation shall be performed in accordance with all applicable API and NFPA codes and standards and the following procedures.

B. Removal of Product: Contractor will remove and properly dispose of product contained in removed piping.

C. Piping: After pipe has been taken out of service, high point vents and low point drains of the pipe shall be opened, and the product shall be drained or vacuumed out. The Contractor shall fabricate, install, and disconnect all temporary connections, as required to vent, drain, and vacuum out the pipe. Contractor shall avoid spilling product on the ground or pavement.

3.04 REMOVAL AND DISPOSAL.

A. All piping to be removed shall be completely drained, purged and cut into pieces suitable for safe transportation to disposal facility.

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 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 Demolition price.

END OF SECTION 024101

SECTION 071416

COLD FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Single-component polyurethane waterproofing.
2. Molded-sheet drainage panels.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

1. Include data substantiating that all materials comply with requirements.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Installer to submit a certificate evidencing not less than five (5) years of successful experienced installing similar types to products specified.

C. Manufacturer to submit a certificate evidencing not less than five (5) years experienced manufacturing types of products specified.

D. Manufacturer to submit a field report that all installation work is being done per contract requirements.

E. Provide a certificate stating that waterproofing and protection board to be used at the horizontal and vertical surfaces of the basement extension has been tested for jet fuel resistance and that the required warranty applies to this work. Provide the actual test report.

1. Minimum Requirements: For waterproofing, expansion joint covers and any associated joints, no loss in waterproofing ability within 48 hours after ponding jet fuel for 72 hours. For protection board, no loss in protection within 48 hours after being immersed in jet fuel for 72 hours.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is acceptable to waterproofing manufacturer for installation of waterproofing required for this Project.

1. Installer will have specialized in installation of types of waterproofing required for project for not less than five (5) years and which is acceptable to manufacturer(s) of primary materials.

2. Assign work closely associated with waterproofing, including (but not limited to) waterproofing accessories, and flashings used in conjunction with waterproofing, expansion joints in membrane, insulation and protection course on membrane, to installer of waterproofing, for single, undivided responsibility.

B. Pre-installation Conference: Approximately two (2) weeks prior to actual commencement of fluid-applied waterproofing installation, meet at project site with Installer, installers of deck or substrate construction to receive work, installers of other work in and around waterproofing work which must precede, follow or penetrate waterproofing work (including mechanical work if any), DEN Project Manager, the Contractor's Quality Control Manager and waterproofing material manufacturer's representative. Record (Contractor) discussions of conference, together with decisions and agreements (or disagreements) reached. Furnish copy of record to each party attending.

1. Review methods and procedures related to work, including but not necessarily limited to the following:
   a. Tour jobsite areas to be waterproofed. Verify existing conditions. Inspect and discuss condition of substrate, drains, curbs, penetrations and other preparatory work performed by other trades.
   b. Review waterproofing requirements (drawings, specifications and other contract documents), including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and flashings, and installation procedures.
   c. Review required submittals. Work cannot begin until all submittals are accepted.
   d. Review and finalize construction schedule related to waterproofing work and verify availability of materials, Installer's personnel, equipment and facilities needed to make progress and avoid delays.
   e. Review required inspection, testing, and certifying procedures, safety and hazardous control programs.
   f. Review protection and repair procedures.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to

a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.

1. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.08 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

2.01 GENERAL

A. General Compatibility: Provide products which are recommended by manufacturer to be fully compatible with indicated substrates, including modification by bituminous additives (asphalt or coal tar as needed) and similar proven compounding provisions.

2.02 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Masterseal HLM 5000 by Masterbuilders/BASF.
   b. Or approved.

B. Single-Component, Reinforced, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Masterseal HLM 5000.
   b. Or approved equal.

2.03 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.

B. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.

1. Backer Rod: Closed-cell polyethylene foam.

2.04 PROTECTION COURSE

A. Protection Course: Masterseal 975 Polypropylene Drain Board System, ASTM D 3776, 0.40-inch minimum thickness, ASTM D 1777.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION

A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

F. Seal joints, and apply bond breakers as recommended by prime materials manufacturer, with particular attention at construction joints.

G. Install accessories as recommended by prime materials manufacturer.

H. Prime substrate as recommended (and only if recommended) by prime materials manufacturer.

3.03 PREPARATION AT TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to manufacturer's written instructions.

B. Prime substrate unless otherwise instructed by waterproofing manufacturer.

C. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

1. Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints when recommended by waterproofing manufacturer.

3.04 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying with ASTM D 4258, before coating surfaces.

3.05 WATERPROOFING APPLICATION

A. Apply waterproofing according to manufacturer's written instructions.

B. Start installing waterproofing with a test application before proceeding with the entire application.

C. Except as otherwise indicated, extend flashings onto perpendicular surfaces and other work penetrating substrate to not less than 6" beyond finished surface to be applied over waterproofing.

D. Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply waterproofing to obtain a seamless membrane free of entrapped gases, per manufacturers recommendations.
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify wet film thickness of waterproofing every 100 square feet (9.3 sq. m).

3.06 PROTECTION COURSE:

A. Install protection course on cured membrane (after testing, if required) without delay, so that period of membrane exposure will be minimized.

B. On all vertical surfaces to be waterproofed install protection course. Comply with waterproofing manufacturer's recommendations for adhesion of protection course to membrane.

3.07 CURING, PROTECTION, AND CLEANING

A. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed drainage panels from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Immediately after installation, provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

PART 5 - MEASUREMENT

5.01 METHOD OF MEASUREMENT

A. "Waterproof Basement Wall" shall be paid for per square foot, for work installed in-place, completed, and approved by DEN PM.

PART 6 - PAYMENT

6.01 METHOD OF PAYMENT

A. Payment for "Waterproof Basement Wall" will be made at the contract unit price per square foot, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 071416-1 Waterproof Basement Wall – per square foot

END OF SECTION 071416

SECTION 134713

CATHODIC PROTECTION – JET FUEL PIPING

PART 1 - GENERAL

1.01 SUMMARY:

A. Section includes requirements for a cathodic protection system that uses galvanic anodes to protect the underground steel jet fuel piping, to supplement factory and field coatings.

1.02 PERFORMANCE REQUIREMENTS:

A. Electrical Isolation: The contractor shall ensure that the new jet fuel pipes are electrically isolated at the isolation valve vaults, hydrant pits and HPV/LPD pits, and from other underground utilities. This includes maintaining at least 12 inches of separation between the new jet fuel pipes and other underground metallic utilities, including static ground cables. The contractor's Cathodic Protection Specialist shall verify electrical isolation, prior to and after paving.

B. Coatings: The contractor shall ensure the underground fuel pipes are provided with a factory applied FBE coating as specified. The field welds must be cleaned and coated with liquid epoxy as specified. The assembled pipes must be subjected to electronic holiday testing prior to burial. The detected coating defects must be repaired with liquid epoxy coatings. The contractor's Cathodic Protection Specialist shall verify that the correct factory coatings are provided, that electronic holiday inspections are conducted correctly, and that coatings are properly repaired.

C. Cathodic Protection Materials: Provide and install cathodic protection components in accordance with the plans and specifications. The contractor's Cathodic Protection Specialist must provide submittal documents that verify the components to be furnished comply with this specification, and onsite technical assistance to verify that the cathodic protection components are properly installed. The contractor's Cathodic Protection Specialist shall inspect the vaults and pits to verify electrical isolation before paving.

D. Quality Control: The contractor's Cathodic Protection Specialist shall prepare a project-specific QC plan for the cathodic protection installation. The QC plan must include testing of test station lead wires prior to backfill and prior to pavement, testing of dielectric gaskets and pipeline isolation prior to pavement, and review and approval of QC tests.

E. Cathodic Protection Commissioning: The contractor's Cathodic Protection Specialist shall inspect the test stations and dielectric gaskets to verify they have been installed correctly. The inspections shall take place before and after paving. Any deficiencies in materials or workmanship will be corrected by the contractor at no cost to the owner. The contractor's Cathodic Protection Specialist will connect and test the cathodic protection system after pavement and issue a compliance report. The cathodic protection system must meet the cited criteria.

F. Flowable Fill: The contractor shall install the cathodic protection components in a manner that is compatible with the use of flowable fill around the fuel pipes. This will include strict coordination of the installation of the cathodic protection components, QC tests before and after the flowable fill is poured and sealing of the test station housings against the flowable fill.

1.03 ACTION SUBMITTALS:

A. Product Data

1. Provide a list of the cathodic protection components with quantities, description, make and model numbers. Each component must be matched to the specification section.
2. Provide a product data sheet for each component listed, mark product data sheets to clearly identify product to be provided, match product to specification section.
   a. Test Station Housing
   b. Test Station Head
   c. Pipe Test Lead Wire
   d. Exothermic Weld Mold
   e. Exothermic Weld Charge
   f. Epoxy Weld Coating
   g. Ring Terminal
   h. Identification Tag
   i. Calibrated Shunt
   j. Anode
   k. Anode Lead Wire
   l. Reference Cell and Lead Wire
   m. Coupon and Lead Wire
   n. Magnetic Switch
   o. Dielectric Gasket
   p. Soil Access Port and Cap
   q. Over Voltage Protection Unit
   r. Protective Flange Band

B. Shop Drawings:

1. Test Station Housing
2. Dielectric Gasket Kit

C. Contractor’s Cathodic Protection Specialist

1. Provide resume with experience, certification and project listing, the submitted person must provide on-site services.

1.04 INFORMATIONAL SUBMITTALS:

A. QC Document: The QC procedure document must include detailed written procedures on the installation of the cathodic protection components, QC testing, and compliance testing. The installation section must include step-by-step procedures to install the anodes, coupons, reference cells, pipe test leads and dielectric gaskets. The QC test section shall address testing requirements before flowable fill and after flowable fill. The compliance test procedure shall address final testing after the ramp pavement and jet fuel pipe installation is complete.

B. QC Reports: The reports must include QC test data and photographs of installed components. Each QC report shall include data, photos, and graphs, and shall be reviewed and signed by the contractor’s Cathodic Protection Specialist. The QC reports shall be submitted to DEN for review and approval prior to placing flowable fill and pavement.

C. Commissioning Report: The report must include tabulated field data, photographs of test stations, analysis of the data, calculated anode service life and statement that all test points meet cited criteria.

D. As-Built Drawings: Submit red-lined drawings with GPS coordinates of each test station.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: Provide the following:

1. Basic system operation, outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown.
2. Instructions for pipe-to-reference cell potential measurements and frequency of monitoring.
3. Troubleshooting, if the potential measurements are low.

1.06 QUALITY ASSURANCE:

A. Contractor's Cathodic Protection Specialist: The contractor shall provide the services of a NACE certified Cathodic Protection Specialist. The Cathodic Protection Specialist shall have at least ten years of experience testing cathodic protection systems on jet fuel hydrant piping. Provide a resume, NACE certification and a list of 5 applicable projects.

B. The contractor's Cathodic Protection Specialist shall provide a QC plan that addresses QC tests to be conducted by the installing contractor. The QC plan must include;

1. A step-by-step description of the installation of the cathodic protection components.
2. Description of QC tests on test station cables to include instrumentation, data forms, step-by-step test procedure for testing before backfilling, and after backfilling, before pavement.
3. Photographs of the cathodic protection components at each test station as they are installed.
4. Installation procedure and test instruments for evaluating dielectric gaskets, protective bands and OVPs.
5. Written compliance test procedure including instrumentation.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Protect anodes from exposure to rain and direct sunlight.

1.08 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which contractor and manufacturer agrees to repair or replace cathodic protection components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of acceptance of the final cathodic protection test report.

PART 2 - PRODUCTS

2.01 MAGNESIUM HIGH POTENTIAL ALLOY ANODES:

A. Chemical composition as percent of weight shall be as follows:

1. Aluminum: 0.01 maximum.
2. Manganese: 0.50 to 1.3.
3. Copper: 0.02 maximum.

4. Nickel: 0.001 maximum.
5. Iron: 0.03 maximum.
6. Silicon: 0.05% maximum.
7. Other Impurities: 0.05 maximum each.
8. Magnesium: Remainder.

B. Bare Anode Weight: 48 lbs., not including core, and a nominal length of 30.125 inches.

C. Anode Wires: Factory-installed cables, with stranded copper conductors, suitable for direct burial; No. 10 AWG with type THWN insulation according to ASTM D1248 and NEMA WC 70/ ICEA S-95-658; 50 feet in length.

D. Anode Backfill: Packaged backfill materials in water-permeable fabric sack or cardboard container. Anodes shall be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material shall have the following chemical composition by weight:

1. Hydrated Gypsum: 75%.
2. Bentonite Clay: 20%.
3. Anhydrous Sodium Sulfate: 5%.

E. Packaged Anode: Total weight of 100 pounds, with nominal diameter of 8 inches and length of 38 inches. Farwest Model 48D5 or approved equal.

2.02 FLANGE ISOLATION KITS

A. Manufactured in accordance with ANSI B16.5.

B. Full face G-10 gaskets with Viton seal, G-10 sleeves of sufficient length to pass through all washers, double G-10 dielectric washers, galvanized backer washers. Match gasket configuration to flange type and rating.

C. APS Model Trojan or approved equal.

2.03 PROTECTIVE FLANGE BAND:

A. Clear virgin vinyl band with stainless-steel worm gear.

B. Sized to match flange.

C. Dielectric inhibitive grease, clear, environmentally friendly.

D. APS Model Kleerband or approved equal.

2.04 OVER VOLTAGE PROTECTION UNIT

A. Class 1 Division 1 rated solid-state over voltage protection unit, rated at -3/+1 DC volts, with nickel-plated copper mounting brackets to fit bolt hole diameters.

B. Dairyland Model OVP -3/+1 – 3.7 – 100 with bracket to match pipe diameter and pressure rating.

C. Above grade application and control vaults only.

2.05 TEST STATIONS:

A. Monitoring test stations shall be a flush-type station designed for use on active airfields or set in concrete. Do not fill test station with concrete. Test station shall be furnished with a non-metallic test head and terminal board equipped with terminal posts to permit ready-access and testing: Dabico/Cavotech Model D9-CPE-24D.

1. Body: Fiberglass 1/4-inch thick, 9-inch inside diameter 24 inches deep, with integral concrete anchors, bottom open to native soil.
2. Cover: Cast aluminum with integral handle, CP-Test cast.
3. Test Head: 3-inch diameter Lexan test head with cover and 8-inch section of 3-inch schedule 40 PVC extension.

B. Lexan terminal board, 6 terminals, stainless-steel hardware. Cott Model Big Fink or approved equal.

C. Calibrated shunt, 0.1-ohm resistance rated at 2 amperes. Cott Model 0.1-Red or approved equal.

D. No. 10 AWG/RHW-USE stranded copper test leads to fuel pipe.

E. Nylon insulated tinned copper crimp type ring terminal.

F. Brass 1.5-inch diameter tag, embossed with test station number.

2.06 EXOTHERMIC WELDING MATERIALS:

A. Exothermic Weld Kits: Specifically designed by manufacturer for welding materials and shapes required, No. 10 AWG stranded copper to horizontal carbon steel pipe.

B. Exothermic Weld Coating: Two-part epoxy, compatible with FBE factory coating, provided in cartridge with mixing tip. Denso Model Protal 7200 or approved equal.

2.07 REFERENCE ELECTRODE:

A. Stationary packaged copper/copper-sulfate reference cell with 30 feet of #10 AWG/RHW-USE (Yellow) test lead.

B. The reference cell shall be designed for underground soil exposure, packaged in low-resistant backfill, with a design service life of 50 years. EDI Model UL50 or approved equal.

2.08 CATHODIC PROTECTION COUPONS

A. Description: Each CP coupon shall have 10 square centimeters of exposed carbon steel with factory installed lead wire, MC Miller Model COU100 – Single wire or approved equal.

B. Provide a single No. 10 AWG/THWN orange lead for energized coupon and No. 10 AWG/THWN purple lead for native coupons, leads shall be 30 feet in length.

C. Provide a magnetic switch for each test station, EDI model SM-ADJ or approved equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS:

A. Comply with ANSI/IEEE C2 and NFPA 70.

B. Make connections to ferrous pipe using exothermic welding.

C. Coat welds with two-part epoxy.

D. Maintain electrical isolation.

E. Conduct QC tests as components are installed.

3.02 MAGNESIUM ANODE INSTALLATION:

A. Install magnesium anodes at locations shown and clear obstructions. Install at least 36 inches from, and no more than 10 feet from, pipe to be protected. Install in vertical augured holes with top of anode 12 inches below flowable fill.

B. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable permanent container that houses anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine native earth in 6-inch layers; compact each layer using hand tools. Do not strike anode or connecting wire during backfilling and compacting. After backfilling and compacting to within 6 inches of finished grade, pour approximately 5 gal. of water into each filled hole. After water has been absorbed by anode and earth, complete backfilling to finished level.

C. If rock strata are encountered before achieving specified augured hole depth, install anodes horizontally at depth at least 12 inches below flowable fill.

D. Install anodes connected through a test station to the pipeline, allowing slack in connecting wire to compensate for movement during backfill operation.

E. Install two anodes per test station.

3.03 INSTALLATION OF REFERENCE ELECTRODES AND COUPONS:

A. Install 12 inches below flowable fill, directly under fuel pipe.

B. Soak cells in fresh water for 4 hours after removing protective bag.

C. Calibrate to a freshly charged portable cell prior to installation.

D. Backfill in sand or native soil, using spacing shown on drawings.

3.04 CABLE AND WIRE INSTALLATION:

A. Anode Wire Installation: Cover trench bottom for the anode wire with 3-inch layer of sand or stone-free earth. Center wire on backfill layer and do not stretch or kink the conductor. Place backfill over wire in layers not exceeding 6 inches deep and compact each layer. Use clean fill, free from roots, rocks, vegetable matter, and refuse.

3.05 TEST CABLE CONNECTIONS:

A. Remove pipe coating in 2-inch squares, 6 inches apart. Clean surface to bright metal and score surface with awl.

B. Strip test lead to fit in weld mold.

C. Place air quality meter next to weld location to verify area is safe for hot work.

D. Place metal disk in weld mold, followed by 15-gram charge and ignition power.

E. Place mold over cable on clean pipe surface, ignite weld, allow to cool 10 seconds, remove mold.

F. Strike weld with 2-pound hammer to remove slag and verify weld is sound.

G. Use wire brush to clean weld area.

H. Apply two-part epoxy coating, allow to cure 6 hours prior to backfill.

3.06 SOIL ACCESS PORT

A. Install soil access port before flowable fill.

B. The 2-inch solid PVC pipe shall be installed vertical from 12 inches below the bottom elevation of the flowable fill, to a point 24-inches above the top of the ramp pavement. Place a 2-inch cap on top of the pipe, leave the bottom of the pipe open.

C. Run the anode, pipe, reference cell and coupon test leads on the outside of the 2-inch pipe, tape the cables to the pipe, coil and flag the cables on the pipe above the top of the flowable fill elevation.

D. Secure the 2-inch pipe and cables as the flowable fill is poured. Once the flowable fill sets up, cut the tube so it extends 10 inches above the flowable fill, and place the cap on the tube. Coil and flag the cables. Place an orange traffic cone over the tube and cables.

3.07 TEST STATIONS:

A. Install test station housings at locations shown.

B. Measure the distance between the top of the installed flowable fill, and the elevation of the proposed ramp concrete. Cut the fiberglass tube to the correct length. Set the housing over the 2-inch soil access tube and cables and seal the base to the flowable fill with clay or similar product to keep poured concrete out of housing.

C. Terminate test conductors on terminal boards within each test head. Contractor’s Cathodic Protection Specialist shall test and terminate cables.

D. Leave 18 inches of slack wire in test station access tube.

E. Do not place any conduits, stakes, or other obstructions within the housings.

F. Seal off the lid with duct tape prior to pouring concrete. Set housing flush with pavement. Remove duct tape after concrete cures.

G. Test stations shall be located minimum 15 ft from hydrant pits and low point drains to avoid contamination with Jet Fuel.

3.08 DIELECTRIC GASKETS:

A. The mechanical plans show the minimum locations of dielectric gaskets to be installed under this project.

B. The contractor's Cathodic Protection Specialist is responsible for verifying if additional dielectric gaskets or spacers are required to effectively electrically isolate the underground jet fuel pipes. The additional gaskets and components shall be provided by the contractor, at no additional cost to the owner.

C. Match the gasket kit to the flange size and rating.

D. Install the flange and gasket, use alignment pins to align the bolt holes, insert the bolts with the dielectric sleeves, dielectric washers and galvanized washers. Do not force bolts.

E. Hand-tighten the bolts evenly around the flange, verify correct orientation of washers.

F. Tighten the bolts in a star pattern, using properly sized box end or socket wrenches. Tighten the bolts with a calibrated torque wrench to the values provided in the following table. Only turn nut, not bolt.

Pipe Diameter (Inches)	Torque (Foot-Pounds)
1	40
1.5	40
2	80
3	110
4	110
6	130
8	130
10	215
12	220
14	320

G. Wipe the face of the assembled flange with dielectric inhibitive grease, place band over flange and tighten.

H. Install OVPs across flanges, where shown in plans. Mount OVP housing on grounded side of flange. Required at above grade flanges and within control vaults.

3.09 FIELD QUALITY CONTROL:

A. Field inspections shall comply with NACE SP0169 (2013) and requirement of this specification. Use the criteria stated below.

B. The contractor's Cathodic Protection Specialist shall submit a Quality Control plan to be followed by the installing contractor as the anodes, reference cells, coupons, test leads and soil access tubes are installed. The contractor must record potential measurements on all test leads, after backfilling, and after flowable fill, but prior to pavement. This data must be submitted to the contractor's Cathodic Protection Specialist for review and approval. Approval must be given prior to backfill and prior to paving. The test data must be accompanied by photos of the installed components. The test data and photos will be submitted to the owner for approval prior to paving. The contractor's Cathodic Protection Specialist must visit the work site at the start of construction to review coating requirements and to witness the installation of the first test station components. The Cathodic Protection Specialist shall also provide training on QC testing, instruments, forms, and document review. The contractor's Cathodic Protection Specialist must review and sign the QC data sheet for each test station prior to burial and prior to paving. The QC documents, including photos, must be submitted to the owner. The contractor shall verify that the fuel pipes remain electrically isolated. QC tests conducted prior to placement of the flowable fill, and prior to pouring the ramp pavement, must confirm electrical isolation. If the pipes are not

electrically isolated, the deficiency must be corrected and retested before proceeding with construction. The corrective action shall be the responsibility of the contractor, at no cost to the owner.

C. Once construction is complete, all pipe components have been installed and the ramp has been paved, the contractor's Cathodic Protection Specialist will test each of the dielectric gaskets with a 601 meter or similar instrument. If any of the flanges with dielectric gaskets are electrically grounded, the contractor must make corrections prior to continuing with the tests. The contractor's Cathodic Protection Specialist shall also verify that wall sleeves, valve stems and other applicable appurtenances are electrically isolated. The contractor's Cathodic Protection Specialist will verify that protective bands and OVPs have been installed correctly.

D. Once the fuel pipelines are shown to be electrically isolated, the contractor's Cathodic Protection Specialist shall commission the cathodic protection system. At each test station, open-circuit potentials shall be recorded to each fuel pipe, anode, reference cell and coupon test lead. At valve vaults, potentials shall be recorded on the protected pipes and unprotected or grounded valves with a reference cell placed in the nearest test station. If this testing determines there are deficiencies with materials or workmanship, corrective action shall be taken by the contractor at no cost to the owner. The repairs must be carried out before continuing with testing. Once the native potential measurements have been recorded at all test stations, all of the test leads shall be terminated on the terminal boards. The test leads shall be labeled, and tags installed on each terminal board. As the test leads are terminated, current applied potentials and anode current output shall be recorded. This initial data shall be submitted to the owner with a brief letter report. A photo of each test station terminal board must be included.

E. The cathodic protection system will then be allowed to operate for 14 days. After this period of operation, the contractor's Cathodic Protection Specialist will record current applied potentials and anode current at each test station and at all new and modified vaults. A potential shall also be recorded at each test station, with the local anodes disconnected for 5 seconds. "Native", "On" and "Instant Off" potential measurements shall also be recorded using the coupons. The interruption for the coupons shall be 2 seconds. The criteria to be used is a polarized or instant off potential measurement of at least -900 millivolts. If protection levels do not meet this criterion, the contractor shall investigate and correct the problem at no cost to the owner. The deficiency and required corrective action shall be submitted to the owner, for review, prior to implementation. The owner must approve the corrective action plan. The contractor's Cathodic Protection Specialist shall retest after repairs, at no cost to the owner. The contractor's Cathodic Protection Specialist shall record submeter GPS coordinates at each test station.

F. Following final testing, the contractor's Cathodic Protection Specialist shall provide a report with a detailed description of the fuel piping and cathodic protection system, tabulated field data, analysis of the data, calculated anode service life, construction Quality Control forms and photos, red-lined drawings, photos of terminal boards, GPS coordinates and Operations and Maintenance manuals. The report must be signed by the contractor's Cathodic Protection Specialist.

3.10 OWNER REPORT REVIEW:

A. The owner's Cathodic Protection Specialist will review each of the reports submitted by the contractor. Any owner comments made on one of the QC or final test reports will need to be resolved by the contractor. Once the final cathodic protection test report has been accepted, the owner's Cathodic Protection Specialist may inspect and test the cathodic protection system. Any deficiencies in materials or workmanship identified by the owner's Cathodic Protection Specialist and will be corrected by the contractor at no cost to the owner. Repairs may require additional tests by the contractor's Cathodic Protection

Specialist, at no cost to the owner.

3.11 DEMONSTRATION:

A. Train owner's maintenance personnel to operate and maintain cathodic protection system, allow 4 hours of site training.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Payment for "Jet Fuel Cathodic Protection" shall be measured via a combination of approved submittals and installed, operational cathodic protection stations.

PART 5 - PAYMENT

5.01 PAYMENT

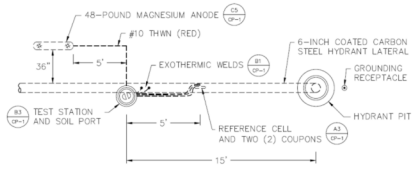
A. Payment for design and installation of jet fuel cathodic protection systems necessary to comply with this specification will be made at the contract unit price per lump sum for work installed in-place, completed, and approved by the DEN. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

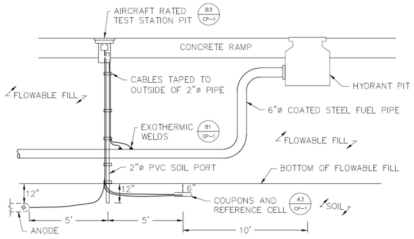
Item 134713-1 Jet Fuel Cathodic Protection – per lump sum

END OF SECTION 13 47 13

REFERENCE DRAWING



C1 CP TEST STATION - TOP VIEW
NTS



C3 CP TEST STATION - SECTION
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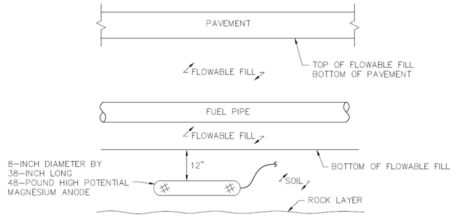

C5 CP ANODES - SECTION
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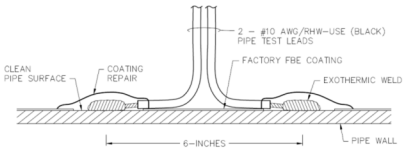

B1 EXOTHERMIC WELD CONNECTION - SECTION
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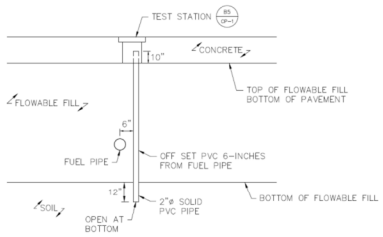
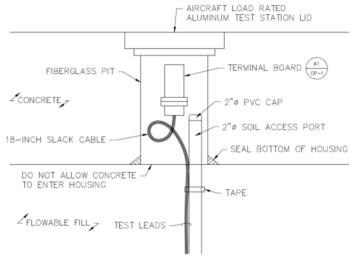
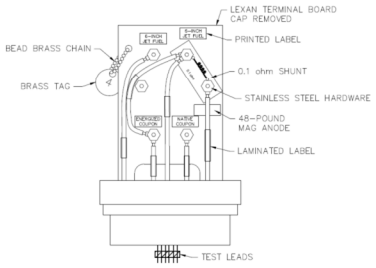


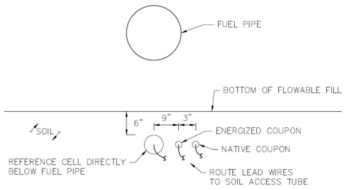
B3 SOIL PORT AND TEST STATION
NTS



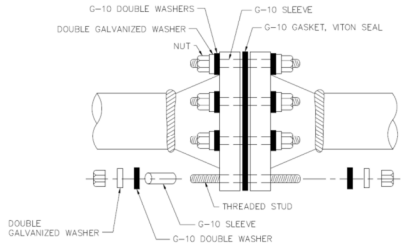
B5 TEST STATION HOUSING - SECTION
NTS



A1 TEST STATION TERMINAL BOARD
NTS



A3 REFERENCE CELL AND COUPONS
NTS



NOTES:
1. WELD NECK FLANGE SHOWN. ASSEMBLY ON OTHER FLANGES IS SIMILAR.
2. INSULATING MATERIALS ARE TO BE SELECTED FOR COMPATIBILITY WITH PRODUCT IN THE PIPELINE AND THE OPERATING CONDITIONS.

A5 DIELECTRIC GASKET ASSEMBLY
NTS

CP–1

CCI REFERENCE NUMBER A–5052–1

*Project drawings shall specify number of anodes per test station

END OF SECTION 134713

SECTION 220400

BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Basic requirements common to the Work in general of Division 22 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 22.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the Work even though not specified or indicated.

D. Inspection: Inspect Work preceding or interfacing with Work of Division 22 and report any known or observed defects that affect the Work to the General Contractor. Do not proceed with the Work until defects are corrected

E. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 REFERENCES

A. General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable Codes.
2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.
3. When required by individual Specifications Section by means of reference for cleaning or installation requirements, etc., obtain a copy of the standard. Maintain the copy at job site during work until substantial completion. Copy may be in electronic format.
4. Schedule of Referenced Organizations: Reference Section 014225 "Reference Standard" for a list of the acronyms of organizations referenced in these Specifications:

1.04 DEFINITIONS

A. Conform to Division 01: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. The following words are re-defined and/or elaborated on for the context of Division 22 Work:

1. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

2. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

3. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

4. General Contractor: The term "General Contractor" used in Division 22 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.

1.05 QUALITY CONTROL

A. Conform to Division 01. Materials and apparatus required for the Work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.

B. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the Manufacturer. This includes the performance of tests as recommended by the Manufacturer.

1.06 REGULATORY REQUIREMENTS

A. Comply with latest editions of all applicable Codes, Standards, Ordinances and Regulations in effect as of the date of the Contract Documents including but not necessarily limited to the following:

1. ABMA - American Bearing Manufacturers Association.
2. ACGIH - American Conference of Governmental Industrial Hygienists.
3. ACI - American Concrete Institute.
4. AGA - American Gas Association.
5. ASHRAE.
6. ANSI - American National Standards Institute.
7. API - American Petroleum Institute.
8. ASTM - American Society for Testing of Materials.
9. AWS - American Welding Society.
10. AWWA - American Water Works Association.
11. FM - Factory Mutual Insurance Association.
12. MSS - Manufacturers Standardization Society of the Valve and Fittings Industry.
13. NACE - National Association of Corrosion Engineers.
14. NAPCA - National Association of Pipe Coating Applicators.
15. National Electrical Code NFPA-70.

16. NFPA - National Fire Protection Association.
17. SMACNA.
18. SSPC - The Society for Protective Coatings.
19. STI - Steel Tank Institute.
20. UL - Underwriters Laboratories.

B. If discrepancies occur between the Contract Documents and any applicable Codes, Guidelines, Ordinances, Acts, or Standards, the most stringent requirements shall apply.

C. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.07 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions: Refer to Division 01, General Requirements.

1. Some materials and equipment are specified by Manufacturer and catalog numbers. The Manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.
2. When alternate or substitute materials and equipment are used, Contractor shall be responsible for space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use.
3. When providing a product and/or service under the qualification of "acceptable equal," Contractor shall be entirely responsible for additional costs incurred due to modifications to the civil, architectural, structural, mechanical, and electrical design that may be required to accommodate the "acceptable equal."
4. Substitute materials and equipment are only allowed to be provided from the Manufacturers listed as approved.

1.08 SHOP DRAWINGS AND PRODUCT DATA

A. General: Comply with the General Conditions of the Contract and with Division 01 - General Requirements.

B. All documents shall be submitted in electronic format. Each submittal shall be in a single security free PDF document. PDF documents shall be compatible with Adobe Acrobat 10.0 or newer. All as-built documents shall be submitted in Revit in accordance with Division 01 – General Requirements.

1.09 CONTRACT RECORD DOCUMENTS

A. General: Comply with the General Conditions of the Contract and with Division 01 - General Requirements.

1.10 OPERATING AND MAINTENANCE DATA

A. Plumbing Contractor shall submit electronic copy containing a single PDF file of the entire maintenance manual to the DEN Project Manager, General Contractor for their approval.

B. The manual shall have:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.

2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown.

3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.

4. Manufacturer's data on each piece of equipment, including:
   a. Installation instructions.
   b. Drawings and specifications (approved shop drawings).
   c. Parts lists.
   d. Complete wiring and temperature control diagrams (approved shop drawings).

5. Each piece identified on any schedule shall be bookmarked in the electronic file by its scheduled tag ID (IE: WH-1).

C. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified elsewhere. Insert a copy.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".

2. Tag all manual operating valves with 1-1/2 inch diameter brass tags attached with chains. Tags are to be sequence numbered with legible metal stamps.

3. Provide a typed tag list or schedule mounted under glass in the room designated by DEN Project Manager stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".

D. Plumbing Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the DEN Project Manager, and General Contractor far enough in advance so that all personnel can be notified.

E. Division 22 Contractor shall provide proof of performance certification of all Plumbing Equipment and Systems to demonstrate that all Plumbing Equipment and Systems are operating to the intent of the design.

1.11 FINAL OBSERVATION

A. Comply with the requirements of Division 01 and the following:

1. Prior to the request for final observation, all Work under the contract shall be completed, all systems shall be in proper working order and placed in operation (System Startup of 48 hours).

2. All plumbing systems shall be properly functioning with quantities shown on the Drawings, and all water circuits shall be adjusted to provide the proper flows.

3. All equipment shall be cleaned. All debris and construction materials shall be removed from the DEN property to a DEN approved landfill off-airport.

4. Pumps shall be tested in accordance with other Division 22 Sections and shall be in proper working order and placed in operation.

5. The temperature control system shall be complete and in proper working order. All instruments shall be properly and accurately field calibrated.

6. At the request of the DEN Project Manager, a representative of the Contractor who is thoroughly familiar with the Project and operation of the various systems shall be present during the final observation to demonstrate proper operation of the equipment and controls. If requested by the DEN Project Manager, the Contractor shall have representatives from the Contractor's subcontractors present to assist during final observation.

1.12 PROJECT CONDITIONS

A. Accessibility:

1. Division 22 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of plumbing Work. The Contractor shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the General Contractor of the Contractor's requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

2. Division 22 Contractor shall locate all equipment, which must be serviced, operated, or maintained in fully accessible positions. Such equipment shall include (but not be limited to) valves, shock absorbers, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the DEN Project Manager prior to making the change.

3. Division 22 Contractor shall provide the General Contractor with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

4. Provide carpentry, masonry, concrete and metal work required for work of this Division where not specifically called for under other Sections.

B. Freeze Protection: Do not run lines in outside walls, or locations where freezing may occur, unless noted otherwise. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

C. Scaffolding, Rigging and Hoisting: Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to OSHA requirements and standards.

1.13 COORDINATION

A. General: Coordinate and order the progress of plumbing Work to conform to the progress of the Work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordinate Work with Division 26 Electrical, and Division 33 Utilities and other Divisions as required to perform the Work.

C. Existing System Interruptions: Comply with Division 01 – General Requirements.

D. Cutting and Patching: Reference Section 017330 "Cutting and Patching".

E. Drawings and Specifications: The Plumbing Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural and Engineering Drawings and equipment to be furnished.

F. Discrepancies: Examine Drawings and Specifications for other parts of the Work, and if any discrepancies occur between the plans for the Work of this Division and the plans for the work of others, report such discrepancies to the DEN Project Manager and obtain written instructions for any changes necessary.

G. Order of Precedence: The precedence of construction documents are as Specified in the General Conditions.

1.14 START-UP PROCEDURES

A. If systems are not to continue in use following the start-up procedures, steps should be taken to ensure against accidental operation or operation by unauthorized personnel.

B. Factory personnel shall be notified as appropriate to start systems requiring their services.

C. Notify the DEN Project Manager in writing a minimum of 48 hours prior to start-up of all major mechanical equipment and systems.

D. Should there be any equipment found which had not been properly started up, it will be the responsibility of this Contractor to arrange for the appropriate personnel to start up the equipment at the Contractor's expense and at a time as scheduled by the DEN Project Manager.

1.15 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract and as per requirements in Division 22 Sections.

B. A schedule of testing shall be drawn up by the Division 22 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. Notify the DEN Project Manager, DEN Mechanical Inspector and DEN Mechanical Engineer in writing a minimum of 72 hours prior to testing of any mechanical equipment and systems.

D. All testing must be performed in the presence DEN Project Manager and or designated representative; the DEN Project Manager's signature for verification of the test must appear on the schedule.

E. All testing must be performed in accord with the procedures set forth in Division 22 and other Sections of the Specifications where referenced. At completion of testing, the schedule shall then be submitted in triplicate to the DEN Project Manager.

F. Make all specified tests on piping, ductwork and related systems as necessary.

G. Make sure operational and performance tests are made on seasonal equipment.

H. Complete all tests required by Code Authorities, such as health codes, building codes, and safety codes.

I. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, valve and pump packing properly adjusted, final adjustments made, drive guards secured in place, lubrication checked and replenished if required.

1.16 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Requirements of the Contract

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping , equipment, fixtures and other such items installed under Division 22 of the Work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

C. Clean Domestic Water Systems in accordance with applicable Division 22 Sections.

1.17 WARRANTIES

A. Conform to Division 01: Provide a written warranty covering the entire plumbing Work to be free from defective materials, equipment and workmanship for a minimum period of two (2) years after date of acceptance. During this period provide labor and materials as required to repair or provide labor and materials required to repair or replace defects. Provide certificates for such items of equipment, which have or are specified to have warranties in excess of one (1) year.

1.18 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 (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

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.

END OF SECTION 220400

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 22 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Flowable backfill for underground piping.
7. Field-fabricated metal equipment supports.
8. Installation requirements common to equipment specification Sections.
9. Cutting and patching.
10. Touch up painting and finishing.
11. Pipe and pipe fitting materials are specified in piping system Sections.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and the Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 220400 "Basic Plumbing Requirements".

C. FAA Sections for Earthwork.

D. Section 050510 "Welding"

E. Section 220553 "Identification for Plumbing Piping and Equipment" for labeling and identifying plumbing systems and equipment.

1.04 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.05 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections:

1. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
2. Prepare coordination drawings according to Division 01 Section "Submittals" to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:
    a. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
    b. Pump metal support details.
3. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the Quality Assurance Article.
4. Floor x-rays and/or ground penetrating radar reports.
5. “As Built” Plans shall be provided in the same format and manner as described above.
6. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24"x36" or 34"x44". Spool drawings shall be submitted in electronic format in Revit in compliance with Division 1 requirements. Files shall not contain security. Other file formats will not be accepted.
7. Field Test Reports: Written reports of each pressure tests specified in Division 22 Sections. Include the following:
    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Failed test results and corrective action taken to achieve requirements.

1.06 QUALITY CONTROL

A. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing by the DIA Project Manager and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

B. Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored, pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

D. Protect flanges, fittings, and piping specialties from moisture and dirt.

E. Deliver fittings with plastic sheeting to protect it from elements. Inspect duct liner for exposure to dirt and tears.

1.08 SEQUENCING AND SCHEDULING

A. Coordinate plumbing equipment installation with other building components.

B. Coordinate the installation of required supporting devices.

C. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work.

D. Coordinate connection of electrical services.

E. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces.

PART 2 - PRODUCTS

2.01 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 22 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

C. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent) – Not industry standard, usually 5% antimony.

D. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded. All welding rod is to be kept in a operable rod oven at all times.

2.03 PIPING SPECIALTIES

A. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Waterway Fittings: Dielectric fittings designed to effectively separate dissimilar metals exposed to water or other electrolytes, conforming to NSF and ASTM F492 standards for continuous use at temperatures up to 225 degrees F and pressures up to 300 psi. Fittings to have electro-zinc-plated steel casings providing for maintained exterior electrical continuity, threaded or flanged ends as applicable, and inert linings.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

2.04 SLEEVE SEALS

A. Reference Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping" for sleeve seals.

2.05 ESCUTCHEONS

A. Reference Section 220518 "Escutcheons for Plumbing Piping" for escutcheons.

1.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 22 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

C. Install piping at indicated slope.

D. Install piping free of sags and bends.

E. Install piping plumb and at right angles and plumb or parallel to building walls. Diagonal runs are prohibited, except where indicated.

F. Install piping tight to slabs, beams, joists, columns, walls, and other building elements.

G. Install fittings for changes in direction and branch connections.

H. Install couplings according to manufacturer's printed instructions.

I. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, rust, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
    a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.

d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.

e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

J. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.

2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

K. Piping below apron, concrete slabs or paving shall be encased in flowable backfill. Refer to Section 033350 "Flowable Backfill Low-Strength Concrete" and Division 31 Sections for material and installation requirements.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the DIA Project Manager.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.03 PAINTING AND FINISHING

A. Refer to FAA Sections for Painting for field painting requirements. Paint color schedule shall conform to ASME A13.1-1996, ”Scheme for the Identification of Piping Systems.”

B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. All rooftop equipment exposed to public or aircraft view shall be painted flat white or grey in accordance with FAA Sections.

3.04 CONCRETE PENETRATIONS

A. Reference Section 017330 "Cutting and Patching" for core drilling and saw cutting requirements.

B. Reference Section 024119 "Selective Demolition" for demolition and removal of selected

portions of a building or structure, and repair procedures for selective demolition operations.

C. All penetrations required through completed concrete construction shall be core drilled or saw cut 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.

1. The Contractor shall provide an interpretation of the x-rays or radar shot and obtain written acceptance from the DIA Project Manager before proceeding with drilling.

3.05 WELDING

A. Qualify welding processes and operators for structural steel according to AWS D1.1 Structural Welding Code - Steel. See Division 05 for additional requirements.

B. All welding shall be inspected in process by a contractor-provided, Certified, Independent Testing Agency by an AWS certified welding inspector.

C. Qualify welding processes and operators for piping according to ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Refer to Division 05 for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1 Structural Welding Code - Steel, as referenced in Part 1.

3.07 DEMOLITION

A. Refer to Division 01 and Division 02 for general demolition requirements and procedures.

B. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

D. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping and associated supports indicated to be removed, provide a shutoff valve with plug or cap in pressurized systems and cap or plug remaining piping with same or compatible piping material. No piping shall be abandoned in place. Repair insulation.

2. Equipment to Be Removed: Disconnect and cap services and remove equipment.

3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
5. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
6. Repair structure floor, ceilings, roof, slabs from removed supports in accordance with Division 03, Division 05, and FAA Sections.

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.

END OF SECTION 220500

SECTION 220517

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.

B. Alternates: Refer to Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, codes or regulations referenced in this Section and with the references listed in other Sections as applicable. Refer to Section 014225 "Reference Standard" for listing of issuing organizations or agencies.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include data substantiating that materials comply with requirements.

B. Submit product samples if requested by DIA Project Manager.

1.05 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

2.01 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

F. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

H. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.02 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
3. Or approved equal.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.
6. Or approved equal.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel. Include two (2) for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.

2. Or approved equal.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

PART 3 EXECUTION

3.01 CONCRETE PENETRATIONS

A. Reference Section 017330 "Cutting and Patching" for core drilling and saw cutting requirements.

B. Reference Section 024119 "Selective Demolition" for demolition and removal of selected portions of a building or structure, and repair procedures for selective demolition operations.

C. All penetrations required through completed concrete construction shall be core drilled or saw cut 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.

D. The Contractor shall provide an interpretation of the x-rays or radar shot and obtain written acceptance from the DIA Project Manager before proceeding with drilling.

3.02 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls.

1. Permanent sleeves are not required for holes in slabs formed by molded -PE or -PP sleeves.

2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.03 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in slabs.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.04 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.05 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.06 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

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.

END OF SECTION 220517

SECTION 220518

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, codes or regulations referenced in this Section and with the references listed in other Sections as applicable. Refer to Section 014225 "Reference Standard" for listing of issuing organizations or agencies.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include data substantiating that materials comply with requirements.

1.05 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

2.01 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish and spring-clip fasteners.

D. One-Piece, Stamped-Steel Type: With chrome-plated finish and set screw fasteners.

E. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and set screw fasteners.

2.02 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
    i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
2. Escutcheons for Existing Piping:
    a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with exposed-rivet hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

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.

END OF SECTION 220518

SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze swing check valves.
3. Bronze gate valves.

B. Related Sections:

1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
3. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.04 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 014225 "Reference Standard" for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Mechanical Engineers:
   a. ASME - Boiler and Pressure Vessel Code.

b. ASME Sec. 9 - Welding and Brazing Qualifications.
c. ASME - Boiler and Pressure Vessel Code.
d. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
e. ASME B16.3 - Malleable Iron Threaded Fittings.
f. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
g. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
h. ASME B31.8 – Gas Transmission and Distribution Piping Systems.
i. ASME B31.9 - Building Service Piping.

2. American Society for Testing and Materials (ASTM):
   a. ASTM A 53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
   b. ASTM A 74 - Cast Iron Soil Pipe and Fittings.
   c. ASTM A 234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
   d. ASTM B 32 - Solder Metal.
   e. ASTM B 88 - Seamless Copper Water Tube.
   f. ASTM B 251 - Wrought Seamless Copper and Copper-Alloy Tube.
   g. ASTM C 14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   i. ASTM C 564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
   j. ASTM D 1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   k. ASTM D 2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   l. ASTM D 2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
   m. ASTM D 3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   n. ASTM D 3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   o. ASTM F 477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

3. American Water Works Association (AWWA):
   a. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
   b. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
   c. AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
   d. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   e. AWWA C651 - Disinfecting Water Mains.
   f. M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

4. American Welding Society (AWS):
   a. AWS A5.8 - Brazing Filler Metal.

5. Cast-Iron Soil Pipe Institute (CISPI): CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
6. International Building Code (IBC) with the Denver Amendments.
7. International Fire Code (IFC) with the Denver Amendments.
8. National Certified Pipe Welding Bureau (NCPWB):
   a. NCPWB - Procedure Specifications for Pipe Welding.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.
   1. Include data substantiating that materials comply with requirements.
   2. Provide manufacturers catalog information. Indicate valve data and ratings.

1.06 CLOSEOUT DOCUMENTS

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. Record actual locations of valves.

B. Operation and maintenance data.
   1. Maintenance data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 EXTRA MATERIALS

A. Provide two (2) re-packing kits for each type and size valve.

1.08 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. Valve Identification: Manufacturer's name and pressure rating marked on valve body.

C. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

D. NSF Compliance: NSF 61 for valve materials for potable-water service.

E. Perform Work in accordance with City and County of Denver plumbing code.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
2. Provide temporary protective coating on cast iron and steel valves.
3. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
4. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
5. Protect internal parts against rust and corrosion.
6. Protect threads, flange faces, grooves, and weld ends.
7. Set angle, gate, and globe valves closed to prevent rattling.
8. Set ball and plug valves open to minimize exposure of functional surfaces.
9. Set butterfly valves closed or slightly open.
10. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

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

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Solder Joint: With sockets according to ASME B16.18.
2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Bray.
   c. Conbraco Industries, Inc.; Apollo Valves.
   d. Crane Co.; Crane Valve Group; Crane Valves.
   e. Hammond Valve.
   f. Jenkins.
   g. Lance Valves; a division of Advanced Thermal Systems, Inc.
   h. Legend Valve.
   i. Milwaukee Valve Company.
   j. NIBCO INC.
   k. Red-White Valve Corporation.
   l. Stockham.
   m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   n. Or approved equal.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.03 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Red-White Valve Corporation.
   k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   l. Zy-Tech Global Industries, Inc.
   m. Or approved equal.
2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.04 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Jenkins.
   g. Kitz Corporation.
   h. Milwaukee Valve Company.
   i. NIBCO INC.
   j. Powell Valves.
   k. Red-White Valve Corporation.
   l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   m. Zy-Tech Global Industries, Inc.
   n. Or approved equal.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron**,** bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Jenkins.
   g. Kitz Corporation.
   h. Milwaukee Valve Company.
   i. NIBCO INC.
   j. Powell Valves.
   k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   l. Zy-Tech Global Industries, Inc.
   m. Or approved equal.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron**,** bronze, or aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Do not install valves with stems inverted.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or gate valves.
2. Throttling Service: Ball valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. Provide and install unions downstream of valves and at equipment or apparatus connections.
3. Provide and install ball or butterfly valves for shut-off and to isolate all equipment, isolate connections to existing piping mains, part of systems as indicated, and/or vertical risers.
4. Provide and install ball valves for throttling, bypass, or manual flow control services.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two pieces, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 125 disc.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Valves shall be paid for per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for valves shall be made at the contract unit price per each, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

220523-1 Valves - Ball Valves – per each

END OF SECTION 220523

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning systems.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable.

B. Applicable Standards:

1. American Welding Society (AWS):
   a. D1.1 - Structural Welding Code - Steel.
   b. D1.2 - Structural Welding Code - Aluminum.
   c. D1.3 - Structural Welding Code - Sheet Steel.
   d. D1.4 - Structural Welding Code - Reinforcing Steel.
2. ASME International (ASME):
   a. B31.1 - Power Piping.
   b. B31.9 - Building Services Piping.
3. Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualification".
4. ASTM International (ASTM):
   a. A36/A37M - Carbon Structural Steel.

b. A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
c. C533 - Calcium Silicate Block and Pipe Thermal Insulation.
d. C552 -Cellular Glass Thermal Insulation.
e. C1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

5. The International Association of Plumbing and Mechanical Officials (IAPMO):
   a. PS42 - Pipe Alignment and Secondary Support Systems.
6. International Fire Code (IFC) with the Denver Amendments
7. International Building Code (IBC) with the Denver Amendments.
8. Manufacturers Standardization Society of The Valve and Fittings Industry Inc. (MSS SP):
   a. 58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. 69 - Pipe Hangers and Supports - Selection and Application.
   c. 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
   d. 90 - Guidelines on Terminology for Pipe Hangers and Supports.
9. Metal Framing Manufacturers Association (MFMA):
   a. 3 - Metal Framing Standards Publication.
   b. 102 - Guidelines for the Use of Metal Framing.
10. The Society for Protective Coatings (SSPC):
    a. PA1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
11. Underwriters' Laboratories (UL):
    a. UL 203 - Pipe Hanger Equipment for Fire Protection Service.

1.05 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, and as follows:

1. Steel pipe hangers and supports.
2. Powder-actuated fastener systems.
3. Pipe positioning systems.

4. 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; include Product Data for all components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.

C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Refer to Section 220400 "Basic Plumbing Requirements" for coordination requirements.

E. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.07 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.08 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".

1.09 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Retain applicable standards below. At a minimum AWS D1.1 is required.
   a. AWS D1.2.
   b. AWS D1.3.
   c. AWS D1.4.

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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

2.01 STEEL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.
   h. Or approved equal.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Manufacturer's standard finish, unless bare metal surfaces are indicated.
8. Metallic Coating: Hot-dipped galvanized.
9. Paint Coating: Epoxy.

10. Plastic Coating: Epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International; a subsidiary of Mueller Water Products Inc.
   b. Empire Industries, Inc.
   c. ERICO International Corporation.
   d. Haydon Corporation; H-Strut Division.
   e. NIBCO INC.
   f. PHD Manufacturing, Inc.
   g. PHS Industries, Inc.
   h. Or approved equal.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel indoors and stainless steel outdoors.
7. Coating: Zinc.

2.04 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Anchors to be tested in accordance with current ICC-ES acceptance criteria A.C. 193 or ACI 355.2. Anchors in to have a current ICC-ES or IAPMO-UES listed Research Report. Anchors to be installed in accordance with the approved ICC-ES or IAPMO-UES Research Report. “Drop-in” anchors are not acceptable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. B-Line Systems, Inc.; a division of Cooper Industries.
   b. Hilti, Inc.
   c. ITW Ramset/Red Head.
   d. Or approved equal.

B. Cast-In Anchors; Short or long plate cast-in anchors designed for top flute installation.

1. Description: carbon steel, multi-thread body with engineered plastic flange. The insert body shall be zinc plated per ASTM B633 Fe/Zn 5 Type III,
2. Manufacturers: Subject to compliance with requirements:
   a. Hilti model KCM-MD (SP/LP).
   b. Simpson.

c. Approved equal.

3. Required approvals:
   a. ICC-ES: ESR-4145 in concrete per ACI 318-14 Ch. 17 / ICC-ES AC446 for cracked and un-cracked concrete.
   b. UL and FM listed for the application.

C. Steel Structure Attachments: Contractor may select welded or mechanically attached. All mechanically attached supports shall have jam nuts or other means to prevent loosening.

1. Welded attachments: U-shaped, carbon steel welded beam attachment similar to Anvil Fir. 66.
2. Service: Recommended for attachment to bottom of beams where loads are considerable and rod sizes are large.
3. Maximum Temperature: 750 degrees-F.
4. Approvals: ANSI/MSS SP-69 and MSS-58 (Type 22).
5. Sizes: Capable of handling rod sizes 3/8-inch through 3-1/2 -inch.

2.05 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c. Or approved equal.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIRO Industries.
   b. Or approved equal.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. Portable Pipe Hangers.
d. Or approved equal.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Portable Pipe Hangers.
   b. Or approved equal.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.06 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & S Mfg. Corp.
   b. HOLDRITE Corp.; Hubbard Enterprises.
   c. Samco Stamping, Inc.
   d. Or approved equal.

2.07 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5,000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as required and in accordance with spans and hanger rod sizes based on MSS SP-69 recommendations. Hanger rod sizes are based on single-rod hangers using ASTM A36-81A or ASTM A575-81 Gr 1020 steel.

1. If local codes or special design considerations necessitate shorter spans or larger rod sizes, they shall govern. Contractor shall adjust requirements as necessary for conditions such as increase in loading caused by valves, fittings, or other conditions.

B. Space steel piping supports to permit normal pitch of pipe lines with deflection and bending stress maintained at a minimum. Except as otherwise required by applicable codes, do not exceed the following support spacings:

Nominal Pipe Size (inches)	Water Service Spacing (feet)	Gas, or Air Service Spacing (feet)	Hanger Rod Min. Diameter (inches)
1/2 and smaller	7	8	3/8
3/4 through 1-1/4	7	9	3/8
1-1/2	9	12	3/8
2	10	13	3/8
3	12	15	1/2
4	14	17	5/8
6	17	21	3/4

C. Support cast iron piping at each joint and in accordance with applicable codes and standards.

D. The maximum support spacing for thin wall aluminum, stainless steel, or copper lines is as follows:

Nominal Pipe Size (inches)	Water Service Spacing (feet)	Gas, or Air Service Spacing (feet)	Hanger Rod Min. Diameter (inches)
1/2 through 3/4	5	6	3/8
1 through 1-1/2	6	8	3/8
2	8	11	3/8
3	10	14	1/2
4	12	16	1/2
6	14	20	5/8

E. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

F. Place a hanger within 12 inches of each horizontal elbow.

G. Use hangers with 1-1/2 inch minimum vertical adjustment.

H. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. NPS 15: 60 inches with 1-inch rod.
7. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

I. Support vertical piping at every floor. Support vertical cast iron pipe at each floor and at each hub.

J. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

K. Support riser piping independently of connected horizontal piping.

L. At changes in pipe flow direction, install piping sufficiently spaced to allow pipe movement without crushing insulation.

M. Mechanical systems shall not share supports and/or hangers with any other systems.

N. Fireproofing: Where hangers require removal of fire proofing, remove minimum amount of fireproofing for hanger attachment. Repair fireproofing per Division 07 Sections.

3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fastener System Installation: Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Insert wedge type expansion shell or shield should be flush with concrete surface in which it is set. This requires the hole in the concrete to be of sufficient depth to accommodate total insertion. Install fasteners according to manufacturer's written instructions.

E. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Reference other Division 22 Sections for plumbing fixtures.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts of length at least as long as protective shield.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 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.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Clean and touchup paint field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal where needed.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 deg F (49 deg C) to 450 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 2.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two (2) rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 20 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 pounds.
    b. Medium (MSS Type 32): 1,500 pounds.
    c. Heavy (MSS Type 33): 3,000 pounds.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

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.

END OF SECTION 220529

SECTION 220533

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention with the following electric heating cables:

1. Self-regulating, parallel resistance.
2. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
3. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in 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. Record actual locations of components.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum three (3) years from date of Substantial Completion.

1.07 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

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BriskHeat.
2. Chromalox.
3. Delta-Therm Corporation.
4. Easy Heat; a division of EGS Electrical Group LLC.
5. Nelson Heat Trace; a division of EGS Electrical Group LLC.
6. Pyrotenax; a brand of Tyco Thermal Controls LLC.
7. Raychem; a brand of Tyco Thermal Controls LLC.
8. Thermon Americas Inc.
9. Trasor Corp.
10. Or approved equal.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

I. Capacities and Characteristics:

1. Maximum Heat Output: 5 W/ft.
2. Piping Diameter: 1-1/2”.
3. Electrical Characteristics for Single-Circuit Connection:
   a. Volts: 120.
   b. Phase: 1.
   c. Hertz: 60.
   d. Maximum Overcurrent Protection: 20A.

2.02 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.03 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4-inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. As shown on Drawings.

3.03 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.04 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Replace all damaged or defective components of heat tracing system, and re-test to verify function and compliance with specifications and project requirements.

3.06 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

1. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

1. No separate payment will be made for work under this Section.

END OF SECTION 220533

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 014225 "Reference Standard" for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Mechanical Engineers (ASME).
2. ASME A13.1 - Scheme for the Identification of Piping Systems.
3. International Building Code (IBC) with the Denver Amendments.
4. International Fire Code (IFC) with the Denver Amendments.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Provide manufacturers catalog literature for each product required.

1. Include data substantiating that materials comply with requirements.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1. Include valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

1.05 CLOSEOUT SUBMITTALS

A. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1. Record actual locations of all tagged valves.

1.06 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.07 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

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. W.H. Brady Co.
2. Panduit Corp.
3. Seton Name Plate Corp.
4. Marking Services, Inc.
5. Or approved equal.

2.02 MATERIALS

A. Color: Unless specified otherwise, conform with ASME A13.1.

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

C. Metal Tags: Brass or aluminum, with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

D. Chart: Typewritten letter size list in anodized aluminum frame.

E. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

F. Underground Plastic Pipe Markers:

1. Bright colored continuously printed plastic ribbon tape of not less than 6 inch wide by 4 mil thick, manufactured for direct burial service.

2. For non-metallic buried piping provide printed foil type tape as manufactured by Marking Services Inc., enabling locating of runs by use of a metal detector.

2.03 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass**,** 0.032-inch; Stainless steel, 0.025-inch; Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch or 1-1/2 inch diameter with smooth edges.

3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.04 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.05 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.06 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.

2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.07 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped

holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.08 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Prepare surfaces in accordance with FAA Sections for stencil painting.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

1. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners and adhesive.
2. Metal Tags: Install with corrosive-resistant chain.
3. Stencil Painting: Apply in accordance with FAA Sections.

B. Locate equipment labels where accessible and visible.

C. Equipment: Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates or stencil painting. Small devices, such as in-line pumps, may be identified with metal tags. At a minimum, the nameplate shall contain the following information:

1. Equipment tag.
2. Equipment location.
3. Service area.
4. Flowrate (cfm/gpm).
5. Capacity (btuh/kw).

D. Equipment and terminal devices above ceiling:

1. Provide adhesive backed plastic nameplate on ceiling grid support directly below equipment identifying unit tag and temperature control node number.

3.03 CONTROLS

A. Identify control panels and major control components outside panels with plastic nameplates. Key to control schematics.

3.04 PIPE LABEL INSTALLATION

A. Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on 1/2 inch or smaller diameter non-insulated piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Each side of penetrations through walls, floors, ceilings, inaccessible enclosures, and at each obstruction.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run.

3.05 VALVE-TAG IDENTIFICATION AND INSTALLATION

A. Install tags on valves and control devices in piping systems, except faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Use metal tags secured with brass 'S' hooks or brass chains.

C. Stamp tags with a unique prefix to identify system to which applied, followed by a number

(example: CW-1, CW-2, etc.). In general, prefix shall match system abbreviations used on drawings where applicable.

D. Provide a typewritten listing of valves including: Valve identification number, location, function, normal position, service, and area served. Mount list as specified and directed. Include additional copy in operation and maintenance manuals.

E. Show valve tag designations on the project record document drawings, including schematic flow diagrams where included with construction documents.

F. Contractor shall prepare and install where directed, in aluminum frames with clear plastic protective cover, a valve location diagram in the form of a series of flow diagrams with each automatic or manually actuated control or shut-off valve clearly identified in sequence with its individual valve tag number. Automatic control valves shall be tagged to match designations shown on the temperature control drawings, and the specified valve charts shall be installed adjacent to valve location diagrams

G. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches minimum, round.

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.07 VALVE CHART AND SCHEDULE

A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed by DIA Project Manager. For HVAC piping identification schedule, reference Section 230553 "Identification for HVAC Piping and Equipment":

3.08 PIPING IDENTIFICATION SCHEDULE

A. Pipe identification and color coding for general-use piping systems shall be in accordance with the following schedule:

Classification:	Band Color:	Stenciled Legend:
Domestic Cold Water	Green	Domestic Cold Water
Soil and Waste Piping	Green	Soil and Waste
Plumbing Vent	Green	Vent
Plumbing Drain	Green	Drain
Roof Drain	Green	Roof Drain

B. *Paint entire pipe color indicated except, for vent piping exposed on exterior of building, paint pipe to match wall color. Certain locations may be exempt by direction of DIA Project Manager.

C. Overflow condensate drain termination shall have a minimum 6 by 6 inches placard that reads as follows:

1. “If water is observed from the pipe below, immediately contact Maintenance Control at (303) 342-2800”.
2. Placard shall have white background with red lettering.
3. Minimum lettering height shall be 1/2 inch.
4. Mount placard a minimum of 48-inches above finish floor.

D. Paint exterior piping and duct systems to match wall colors.

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.

END OF SECTION 220553

SECTION 220719

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Sanitary waste piping exposed to freezing conditions.
3. Storm-water piping exposed to freezing conditions.

B. Related Sections:

1. Section 220400 "Basic Plumbing Requirements".
2. Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".
3. Section 220533 "Heat Tracing for Plumbing Piping".
4. Section 220553 "Identification for Plumbing Piping and Equipment".

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 014225 "Reference Standard" for listing of issuing organizations or agencies.

1. Applicable Standards:
   a. American Society for Testing and Materials (ASTM):
   b. A666 – Austentic Stainless Steel, Strip, Plate, and Flat Bar.
   c. B209/B209M – Aluminum and Aluminum-Alloy Sheet and Plate.
   d. C195 – Mineral Fiber Thermal Insulating Cement.
   e. C196 – Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
   f. C449/C449M – Mineral Fiber Hydraulic-Setting Thermal Insulating and Finish Cement.
   g. C533 – Calcium Silicate Block and Pipe Thermal Insulation.
   h. C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   i. C547 – Mineral Fiber Preformed Pipe Insulation.
   j. C552 – Cellular Glass Block and Pipe Thermal Insulation.
   k. C553 – Mineral Fiber Blanket and Felt Insulation for Commercial and Industrial Applications.
   l. C578 - Preformed, Block Type Cellular Poly¬styrene Thermal Insulation.
   m. C610 - Expanded Perlite Block and Pipe Thermal Insulation.

n. C612 – Mineral Fiber Block and Board Thermal Insulation.
o. C921 – Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
p. C1126 – Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
q. E84 – Test Method for Surface Burning Characteristics of Building Materials.

2. International Building Code (IBC) with the Denver Amendments.
3. International Fire Code (IFC) with the Denver Amendments.

A. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.04 ACTION SUBMITTALS

A. Submit product description, list of materials and thickness for each service, and locations.

B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
1. Include data substantiating that materials comply with requirements.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
2. Jacket Materials for Pipe: 12 inches long by NPS 2.
3. Sheet Jacket Materials: 12 inches square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

B. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Deliver, store, protect, and handle products under provisions of Section 220400 "Basic Plumbing Requirements" and Division 01.

C. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Store insulation in original wrapping and protect from weather and construction traffic.

E. Protect insulation against dirt, water, chemical, and mechanical damage.

1.09 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.10 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

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

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Pittsburgh Corning Corporation; Foamglas.
   b. Or approved equal.
2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
   d. Or approved equal.

2.02 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
   b. Or approved equal.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.
   e. Or approved equal.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.

b. Vimasco Corporation; 749.
c. Or approved equal.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
   b. Eagle Bridges - Marathon Industries; 501.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
   d. Mon-Eco Industries, Inc.; 55-10.
   e. or approved equal.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
   b. Eagle Bridges - Marathon Industries; 570.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
   d. Or approved equal.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.

e. Vimasco Corporation; WC-1/WC-5.
f. or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.04 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.
   d. or approved equal.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.05 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Phenolic Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Or approved equal.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. or approved equal.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.
   b. Or approved equal.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
   b. Vimasco Corporation; Elastafab 894.
   c. Or approved equal.

2.07 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.
   b. Or approved equal.

2.08 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.
   d. Or approved equal.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper; 3-mil-thick, heat-bonded polyethylene and kraft paper; 2.5-mil-thick polysurlyn.
   d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper; 2.5-mil-thick polysurlyn.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

C. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Pittsburgh Corning Corporation; Pittwrap.
   b. Polyguard Products, Inc.; Insulrap No Torch 125.
   c. Or approved equal.

2.09 TAPES

A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
   e. Or approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
   c. Or approved equal.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.
   b. Or approved equal.

PART 3 - EXECUTION

3.01 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

3.02 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 degrees F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes according to the manufacturer's written instructions and N.I.C.A standards, with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
5. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Circumferential Joints: Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Longitudinal Seams: Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
   b. For below-ambient services, apply vapor-barrier mastic over staples.
4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retarder mastic.
6. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
7. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.05 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies.

3.06 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more

specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same

thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.07 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

B. Jacket Applications:

1. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have standard jackets, with vapor barrier, factory-applied or field-applied. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets may be used if in accordance with specified flame spread and smoke developed limitations.

2. Indoor, Concealed Applications: Insulated dual-temperature pipes or pipes conveying fluids below ambient temperature shall have vapor barrier jackets, factory-applied or field-applied. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with glass cloth and vapor barrier adhesive.

3. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with reinforced white kraft and aluminum foil laminates. Do not use PVC jackets.

4. Exterior Applications: Provide vapor barrier jackets. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement.

5. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

3.10 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by DIA Project Manager. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by DIA Project Manager, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of

threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1-1/4 and Larger: Insulation shall be the following:
   a. Flexible Elastomeric: 1 inch thick.

B. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:
   a. Cellular Glass: 1-1/2 inches thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:
   a. Cellular Glass: 2 inches thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 2 inches thick.

B. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:
   a. Cellular Glass: 2 inches thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. None.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed: None.

D. Piping, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. The insulation shall be paid for per linear foot, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for insulation shall be made at the contract unit price per linear foot, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

220719-1 Insulation for 1-1/2" Piping – per linear foot

END OF SECTION 220719

SECTION 221116

DOMESTIC WATER PIPING

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:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

2. Encasement for piping.

1.03 ACTION SUBMITTALS

A. Product Data: For transition fittings, dielectric fittings and accessories.

1. Include data substantiating that materials comply with requirements.

B. Welders Certificate: Include welders' certification of compliance with ASME SEC 9 and section 050510 "Welding".

C. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24 x 36 or 34 x 44. Spool drawings shall be submitted in either the latest version of AutoCAD (dwg) or the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

1.04 INFORMATIONAL SUBMITTALS

A. Pneumatic Leak Test for water systems:

1. Contractor shall submit drawings and procedures of the pneumatic leak test to the DIA Mechanical Engineer no later than two (2) weeks prior to testing. Contractor may not proceed with tests unless approved in writing by the DIA Mechanical Engineer or DIA Mechanical Inspector.

B. Disinfection and other Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements

1.05 CLOSEOUT SUBMITTALS

A. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

B. Record actual locations of valves.

C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 EXTRA MATERIALS

A. Provide two (2) repacking kits for each type and size valve.

1.07 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ASME Sec 9.

D. Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

1.08 REGULATORY REQUIREMENTS

A. Perform Work in accordance with City and County of Denver plumbing code.

B. Conform to code for installation of backflow prevention devices.

1.09 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify DIA Project Manager no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without DIA Project Manager's written permission.

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

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

D. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.03 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Tube.

C. Color: Natural.

2.05 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Piping Specialties Products.
   c. Ford Meter Box Company, Inc. (The).
   d. JCM Industries.
   e. Romac Industries, Inc.
   f. Smith-Blair, Inc.; a Sensus company.
   g. Viking Johnson.
   h. Or approved equal.

2.06 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Elster-Perfection Corporation.
   d. Hart Industries International, Inc.
   e. Jomar International.
   f. Matco-Norca.
   g. McDonald, A. Y. Mfg. Co.
   h. Watts; a division of Watts Water Technologies, Inc.
   i. Wilkins; a Zurn company.
   j. Or approved equal.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Elster-Perfection Corporation.
   d. Matco-Norca.
   e. Watts; a division of Watts Water Technologies, Inc.
   f. Wilkins; a Zurn company.
   g. Or approved equal.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Except as otherwise specifically indicated, insulating joint assemblies shall be provided at all riser locations where buried metallic piping (other than copper piping 2 inches or smaller in size) transitions to aboveground extensions. Assemblies shall consist of dielectric fittings or insulating flange assemblies as appropriate for the application. Insulating flange assemblies shall conform to the following requirements:
   a. Flanged joints shall include full face insulating gaskets, insulating bolt sleeves and double quantity of insulating washers and stainless steel washers.
   b. Insulating materials shall be as follows:
      1) Gasket: NEMA Grade G10 retainer conforming to ASTM D 229 with Teflon ring seal on each side of the retainer. Minimum dielectric strength shall be 500 volts per mil (VPM). Compressive strength shall be 50,000 psi. Water absorption shall be 0.05 percent (max.)
      2) Sleeves: Shall be 1/32-inch wall thickness, length to suit two class 150 lb. weld neck flanges, insulating gaskets and valve body thickness. Sleeve shall provide "full" insulation of studs; minimum dielectric strength shall be 500 VPM. Material shall be NEMA Grade G10.
      3) Insulating washers: NEMA Grade G10, 1/8-inch thick (minimum).
2. Install insulating joints at the locations indicated on the drawings. Where not shown on the drawings, they shall be installed within 24 inches of the location at which underground piping transitions to aboveground or within-structure extension.
3. Insulating assemblies shall provide a minimum resistance of 500,000 ohms when tested.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Elster-Perfection Corporation.
   e. Pipeline Seal and Insulator, Inc.
   f. Or approved equal.
5. Nonconducting materials for field assembly of companion flanges.

6. Pressure Rating: 150 psig.
7. Gasket: Neoprene or phenolic.
8. Bolt Sleeves: Phenolic or polyethylene.
9. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elster Perfection Corporation.
   b. Grinnell Mechanical Products; Tyco Fire Products LP.
   c. Matco-Norca.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.
   f. or approved equal.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Comply with requirements in FAA Section P-152 “Excavation, Subgrade, and Embankment" for excavating, trenching, and backfilling.

3.02 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.03 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.04 EXCAVATION

A. Excavate and backfill in accordance FAA Sections’ requirements for work of this Section.

B. All piping installed below concrete slabs, aprons or roadways shall be encased in flowable backfill. Refer to FAA Section “P-153 “Controlled Low-Strength Material".

3.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 220400 "Basic Plumbing Requirements" and Division 01.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

3.06 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

3.07 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

T. Provide dielectric fittings wherever jointing dissimilar metals.

U. Route piping in orderly manner and maintain gradient.

V. Install piping to conserve building space and not interfere with use of space. Refer to Section 220400 "Basic Plumbing Requirements" for coordination requirements.

W. Group piping whenever practical at common elevations.

X. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

Y. Provide clearance for installation of insulation and access to valves and fittings.

Z. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 installer.

AA. Slope water piping and arrange to drain at low points.

BB. Establish elevations of buried water piping outside the building at depth of not less than 12 inches below average local frost depth or as required under applicable codes.

CC. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

DD. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to FAA Sections.

EE. Install valves with stems upright or horizontal, not inverted.

FF. Lever handle valves: Install valve handle so that the handle opens in the direction of fluid flow.

3.08 APPLICATION

A. Provide and install unions downstream of valves and at equipment or apparatus connections.

B. Provide and install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

C. Provide and install ball or butterfly valves for shut-off and to isolate all equipment, isolate connections to existing piping mains, part of systems as indicated, and/or vertical risers.

D. Provide and install ball valves for throttling, bypass, or manual flow control services.

3.09 ERECTION TOLERANCES

A. Slope water piping and arrange to drain at low points.

3.10 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.11 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.12 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.13 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer’s written instructions.

3.14 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.15 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.16 FIELD QUALITY CONTROL

A. Perform the following inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Perform the Following Piping Tests:

1. Perform all tests in the presence of the authorized City representative when required. Contractor shall provide inspector 48-hour prior notice of test; also notify DIA Project Manager.
2. Hydrostatic Leak Test:
   a. Perform hydrostatic leak test on all piping systems prior to making final connections to fixtures and equipment.
   b. Hydrostatic Leak Test Procedure:
      1) Leak test procedures shall comply with ASME B31.9.
      2) Fill piping systems with clear water, vent all air, and pressurize at 150 percent of operating pressure, (but not less than 100 psi or more than the pipe rating pressure) for 15 minutes. Test fails if leakage is observed, or pressure drop exceeds 5 percent of test pressure.
3. No piping or joint shall be left untested. All leaks shall be repaired and the piping system shall be re-tested until satisfactory results are obtained.

4. Pneumatic Leak Test:
   a. General: Pneumatic leak tests shall only be used on piping with restricted access, piping exposed to freezing conditions, or where water leakage would damage critical DIA operational equipment.
      1) Contractor shall submit a written request for test in accordance with the SUBMITTALS Article of this specification Section.
   b. Pneumatic Test Procedure:
      1) Contractor shall submit safety plan for pneumatic testing prior to test.
      2) General: Compressed gas poses the risk of sudden release of stored energy. For that reason, pneumatic testing shall be used only within the following limitations:
         a) The piping system does not contain cast iron pipe or plastic pipe subject to brittle failure.
         b) The system does not contain soldered or solvent cement joints over NPS 2.
         c) The test pressure does not exceed 150 psig.
      3) Test Medium: The gas shall be nonflammable and nontoxic.
      4) Preliminary Test: Prior to application of full pneumatic test pressure, a preliminary test of not more than 10 psig shall be applied to reveal possible major leaks. Pneumatic test pressure is as follows:
         a) Except as limited in Subparagraph b below, the test pressure shall not exceed 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium at each stage.
         b) The test pressure shall not exceed the maximum allowable pneumatic test pressure for any vessel, pump, valve, or other component in the system under test.
      5) Examination for Leakage: After the preliminary test, pressure shall be raised in stages of not more than 25 percent up to full pneumatic test pressure, allowing time for equalization of strains and detection of major leaks at each stage. Following the application of test pressure for at least 10 minutes, the pressure may be reduced to design pressure and examination shall be made for leakage of the piping. Leaks may be detected by soap bubble, halogen gas, scented gas, test gage monitoring, ultrasonic, or other suitable means. If leaks are found, pressure shall be vented, appropriate repair or replacement shall be made, and the pneumatic test repeated until no leakage is found.
      6) Contractor shall measure the surface temperature of the pipe for the duration of testing. The pneumatic test will be deemed successful only when the test pressure can be held at a constant pipe surface temperature for a period of no less than 10 continuous minutes. Record of the pipe temperatures and pressures during the duration of the test shall be submitted to the DIA Project Manager following completion of the test.
5. Testing shall be witnessed by DIA Mechanical Inspector and DIA Project Manager or Designated Representative.
6. Repair piping systems which fail required piping test, by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
7. Drain test water from piping systems after testing and repair work that has been completed.
8. Prepare written report of testing procedures and result. Submit in accordance with Section 220400 "Basic Plumbing Requirements".

3.17 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.18 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

3.19 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Copper Tubing: ASTM B 88, Type L, hard drawn.
   a. Fittings: ASME B 16.22, wrought copper and bronze.
   b. Joints: ASTM B 32, solder, Grade 95TA.

3.20 VALVE SCHEDULE

A. Reference other Division 22 Sections on valves for more information on specific valve types and applications.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

3. Drain Duty: Hose-end drain valves.

C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. The piping shall be paid for per linear foot, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for piping shall be made at the contract unit price per linear foot, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

221116-1 CU, Type L Glycol 1-1/2" Piping (CWHS & CWHR Sum) – per linear foot

END OF SECTION 221116

SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Drain valves
2. Ball Valves
3. Water-hammer arresters.
4. Air vents.
5. Flexible connectors.

B. Related Requirements:

1. Section 221116 "Domestic Water Piping".

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Provide component sizes, rough-in requirements, service sizes, and finishes.
2. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.
2. For fabricated items, indicate dimensions, weights, and placement of openings and holes.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1. Indicate frequency of treatment required for interceptors.
2. Include installation instructions, spare parts lists, exploded assembly views.

B. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers.

C. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

D. DELIVERY, STORAGE, AND HANDLING

1. Deliver, store, protect and handle products under provisions of Section 220400 "Basic Plumbing Requirements" and Division 01.
2. Accept specialties on site in original factory packaging. Inspect for damage.
3. Remove and perfect installation instructions for inspection.

1.06 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.07 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

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.04 BALL VALVES

A. 2 inches smaller:

1. Ball Valves, Solder Joint Ends: 150 psig, brass body, stainless steel ball, RPTFE seats, lever operated, lead-free materials, Apollo 70LF-200 Series.

2.05 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Precision Plumbing Products, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products.
   i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
   j. Or approved equal.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Provide in all stainless steel construction, metal-bellows type with pressurized metal cushioning chamber, precharged, suitable for operation in temperature range -100 to +300 degrees F and maximum 250 psig working pressure.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.06 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.
   a. Handle: Wheel.

2.07 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Flex Pression, Ltd.
   4. Flex-Weld Incorporated.
   5. Hyspan Precision Products, Inc.
   6. Mercer Gasket & Shim, Inc.
   7. Metraflex, Inc.
   8. Proco Products, Inc.
   9. TOZEN Corporation.
   10. Unaflex Universal Metal Hose; a Hyspan Company.
   11. Or approved equal.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install water-hammer arresters in water piping according to PDI-WH 201.

B. Install air vents at high points of water piping Install drain piping and discharge onto floor drain.

C. Install water hammer arrestors complete with accessible isolation valve.

D. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to other Division 22 Sections for general-duty ball, butterfly, check, gate, and globe valves.

E. Install air vents at piping high points. Include ball, gate, or globe valve in inlet and drain piping from outlet to floor drain.

F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect plumbing specialties to piping specified in other Division 22 Sections.

D. 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 and UL 486B.

E. Connect plumbing specialties and devices that require power according to Division 26 Sections.

3.03 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and their installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

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.

END OF SECTION 221119

SECTION 221226

POTABLE WATER CABINETS

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:

1. This Section specifies potable water cabinets, accessories, and trim.

B. Related Requirements:

1. Section 220400 "Basic Plumbing Requirements".
2. Section 221316 "Domestic Water Piping" for piping work.
3. Section 221119 "Domestic Water Piping Specialties" for piping specialties.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 REFERENCES

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. A167 - Stainless and Heat-Resisting Chromium - Nickel Steel Plate, Sheet, and Strip.
   b. A480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   c. E84 - Surface Burning Characteristics of Building Materials.
2. International Building Code (IBC) with the Denver Amendments.

International Fire Code (IFC) with the Denver Amendments.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Submit product data and installation instructions for each fixture, faucet, specialties, accessories, and trim specified.
2. Submit frame paint salt spray test certification and painting specifications and procedures.
3. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages.

C. Wiring Diagrams: Submit manufacturer's electrical requirements and wiring diagrams for

power supply to units. Clearly differentiate between portions of wiring that are factory installed and field installed portions.

1.05 INFORMATIONAL SUBMITTALS

A. Quality Control Submittals:

1. Submit certification of compliance with specified ANSI, UL, FDA, and NSF Standards.
2. Submit certification of compliance with performance verification requirements specified in this Section

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: Include data in Maintenance Manual specified in DIVISION 01.

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".

1.07 EXTRA STOCK

A. Extra Stock:

1. Furnish special wrenches and other devices necessary for servicing potable water cabinets, accessories, and trim to DEN Project Manager with receipt in a quantity of minimum one (1) device for each ten (10) potable water cabinets.

1.08 QUALITY ASSURANCE

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of potable water cabinets of the type required whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Codes and Standards:

1. Food and Drug Administration (FDA).
2. Uniform Plumbing Code (UPC).
3. Underwriter's Laboratories (UL).

1.09 DELIVERY, STORAGE AND HANDLING

A. Store potable water cabinets where environmental conditions are uniformly maintained within the manufacturer's recommended temperatures to prevent damage.

B. Store potable water cabinets and trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture or trim.

1.10 SEQUENCE AND SCHEDULING

A. Schedule rough-in installations with the installation of other building components.

1.11 WARRANTY

A. Warranty of all equipment described in this Section shall meet warranty requirements of Section 220400 "Basic Plumbing Requirements".

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

2.01 POTABLE WATER CABINET MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. NMC-WOLLARD, 2021 Truax Blvd., Eau Claire, WI 54703.
2. Semler Industries, Inc., 3800 N. Carnation St., Franklin Park, IL 60131-1295.
3. J&B Aviation Services, Inc., 2850 Cordelia Road, Fairfield, CA 94534.
4. or approved equal.

2.02 POTABLE WATER CABINETS

A. General: Furnish and install a potable water cabinet near each loading bridge's rotunda column or as indicated.

1. Each potable water cabinet shall consist of a motorized hose reel, water hose, valves, pressure regulator, pressure gauge, flushing air gap, cabinet floor drain, aircraft coupling reduced pressure type back flow preventer, heated service cabinet and skirted stand.
2. Components shall be arranged in the cabinet to allow for maintenance and cleaning without removal of any equipment.

B. Cabinet:

1. Cabinet sidewalls, door and top shall be constructed of welded, double wall stainless steel with a 1-inch polystyrene insulation between minimum 16 gage, type 304 stainless steel sheets, #4 finish inside and outside. Interior corners shall be rounded to provide cleanable surface.
2. Cabinet floor shall be constructed of a single sheet of 304 stainless steel, minimum 16 gage.
3. Cabinet floor shall have a 1-1/2-inch drain opening and drain fitting suitable for connection to drain piping located below cabinet.
4. Cabinet doors shall be of same construction as cabinet and shall have a two point latching system. Doors shall be field replaceable.

C. Stand:

1. Cabinet shall be mounted on a skirted stand such that cabinet floor is at least 18-inches above the adjacent apron elevation.
2. Stand shall be fabricated of type 304 steel (per manufacturer's recommendation), factory painted with rust inhibiting primer and two coats of paint.
3. Stand shall be skirted with minimum 18 gage, type 304 stainless steel sheets having 1-inch urethane board insulation.

D. Electrical:

1. All components shall be UL listed and of NEMA 3R or 4X construction.
2. Light: Provide 100 watt incandescent equivalent LED light fixture switched within cabinet, with weatherproof guard.
3. Heater: Provide cabinet electric heater(s), minimum 2400 watts total. Heater elements shall be electric panel type enclosed within the cabinet side panels. Heat shall be controlled through thermostat mounted inside cabinet and normally set for 40 degrees F.
4. Warning Light: Provide amber light mounted on top of cabinet with door switch to activate light whenever doors are not fully closed.
5. Power Supply: Contractor shall coordinate required power supply with electrical. Provide any transformers required.
6. Convenience Outlet: Provide a convenience outlet inside the cabinet, 120 VAC, 15 amp, GFI, duplex.

E. Hose Reel:

1. Construction: Stainless steel disks and internals, an aluminum drum, carbon steel frame with epoxy powder paint. Frame to be constructed of stainless steel (per manufacturer's recommendation.) Paint color: silver. Frame painting must pass a minimum 500 hr salt spray test.
2. Hose reel shall be electric rewind with minimum 1/2 HP, reversible motor with push button control and limit switch.
3. Reel shall have auxiliary hand crank and adjustable drag brake.
4. Reel shall have 1-inch stainless steel swing joint and stainless steel internal piping.
5. Reel shall be mounted in the vertical position.
6. Drum, disc and sprocket shall be stainless steel.
7. Hose: Provide 250 feet of 3/4-inch I.D. drinking water hose complying with FDA-CFR Title 21, parts 170 through 199. Hose to meet NSF 51 and 61 and be phthalate free.
8. Hose Cover: opaque, colored, and abrasion and weather resistant.
9. Hose End Nozzle: 3/4-inch, aluminum construction, with dust cap and chain suitable for quick coupling to aircraft connections.
10. Hose End Nozzle Tip: 3/4-inch, aluminum construction.
11. Shut off valve: 3/4-inch ball valve at hose end nozzle. Handle shall be oriented 90 degrees from standard position.

F. Piping:

1. Provide the following piping components, factory assembled within each cabinet:
   a. Reduced pressure backflow preventer, 1-inch size, equivalent to Watts Series 909 with unions, bronze strainer, and full port bronze ball shutoff valves.
   b. Pressure regulator, adjustable 25 psi to 75 psi outlet pressure with pressure gauge.
   c. Flexible hose reel connector, minimum 8-inches long.
   d. Flushing Air Gap: 3/4-inch stainless steel air gap piped through the cabinet floor and suitable for connecting with hose end nozzle to facilitate hose flushing.
   e. Shut off valve: 1-inch ball valve at cabinet.

G. Placard:

1. ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message “POTABLE WATER.” Minimum three-inch height. Provide holes for mechanical fastening.

2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

3. Thickness: 1/8 inch.

4. Fasteners: Self-tapping, stainless-steel screws.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all potable water cabinets may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing potable water cabinets.

C. Examine apron, walls, and floors for suitable conditions where potable water cabinets are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install potable water cabinets level and plumb, in accordance with manufacturer's written instructions, rough-in drawings, and applicable codes and regulations, the original design, and the referenced standards.

B. Fasten potable water cabinets securely to apron, supports, or building structure. Secure supplies behind or within wall construction to provide rigid installation.

C. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished.

3.03 FIELD QUALITY CONTROL

A. Prior to putting potable water cabinets into service, perform the following tests:

1. Test potable water cabinets to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

2. Inspect each installed unit for damage. Replace damaged potable water cabinets.

3.04 ADJUSTING

A. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow and stream.

B. Replace washers of leaking or dripping faucets and stops.

3.05 CLEANING

A. Clean potable water cabinets, trim, and strainers using manufacturer's recommended cleaning methods and materials.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Installation of new potable water cabinet shall be paid for per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment will be made at the contract unit price per each, for work installed in-place, completed, and approved by the DEN PM. This price shall include full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the work for this item.

Payment will be made under:

Item 221226-1 Potable Water Cabinet – per each

END OF SECTION 221226

SECTION 221313
FACILITY SANITARY SEWERS

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. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron, gravity sewer pipe and fittings.
4. Ductile-iron, pressure pipe and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Nonpressure-type transition couplings.
8. Pressure-type pipe couplings.
9. Expansion joints and deflection fittings.
10. Backwater valves.
11. Cleanouts.
12. Encasement for piping.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Non-pressure and pressure couplings
3. Expansion joints and deflection fittings.
4. Backwater valves.
5. Cleanouts.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.7 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Extra-Heavy class.

B. Gaskets: ASTM C564, rubber.

C. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A888 or CISPI 301.

B. CISPI-Trademark, Shielded Couplings:

1. Description: ASTM C1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Shielded Couplings:

1. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Shielded Couplings:

1. Description: ASTM C1277 with ASTM A48/A48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Unshielded Couplings:

1. Description: ASTM C1277 and ASTM C1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A746, for push-on joints.

B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.

D. Gaskets: AWWA C111/A21.11, rubber.

2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Push-on-Joint Piping:

1. Pipe: AWWA C151/A21.51.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron.
3. Compact Fittings: AWWA C153/A21.53.
4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

2.5 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D2661, with bell-and-spigot ends for gasketed joints.

1. NPS 3 to NPS 6: SDR 35.
2. NPS 8 to NPS 12: SDR 42.

B. Gaskets: ASTM F477, elastomeric seals.

2.6 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Sewer Piping:

1. Pipe: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, SDR 35, PVC socket-type fittings.

B. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

C. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

D. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

E. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

F. PVC Pressure Piping:

1. Pipe: AWWA C900, Class 150 and Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 150 and Class 200 PVC pipe with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Water-Service Piping:

1. Pipe: ASTM D1785, Schedule 40 and Schedule 80 PVC, with plain ends for solvent-cemented joints.
2. Fittings: ASTM D2466, Schedule 40 and ASTM D2467, Schedule 80 PVC, socket type.

2.7 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
2. For Concrete Pipes: ASTM C443, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.8 PRESSURE-TYPE PIPE COUPLINGS

A. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

B. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

C. Center-Sleeve Material: Stainless steel.

D. Gasket Material: Natural or synthetic rubber.

E. Metal Component Finish: Corrosion-resistant coating or material.

2.9 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:

1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:

1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.10 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.

2. Horizontal type; with swing check valve and hub-and-spigot ends.
3. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
4. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:

1. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.11 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

2. Top-Loading Classification(s): Extra-Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.12 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: tube.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Item D-701 Pipe for Storm Drains and Culverts.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 48-inch minimum cover.

4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron, gravity sewer piping according to ASTM A746.
7. Install ABS sewer piping according to ASTM D2321 and ASTM F1668.
8. Install PVC cellular-core sewer piping according to ASTM D2321 and ASTM F1668.
9. Install PVC corrugated sewer piping according to ASTM D2321 and ASTM F1668.
10. Install PVC profile sewer piping according to ASTM D2321 and ASTM F1668.
11. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
12. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
5. Join ABS sewer piping according to ASTM D2321 for elastomeric-seal joints.
6. Join PVC cellular-core sewer piping according to ASTM D2321 and ASTM F891 for solvent-cemented joints.
7. Join PVC corrugated sewer piping according to ASTM D2321.
8. Join PVC profile sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
9. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
10. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
11. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

B. Join force-main, pressure piping according to the following:

1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping according to AWWA M23 for gasketed joints.

4. Join PVC water-service piping according to ASTM D2855.
5. Join dissimilar pipe materials with pressure-type couplings.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Shielded flexible or rigid couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure pipe couplings for force-main joints.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Extra-Heavy-Duty, top-loading classification cleanouts.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.6 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Item D-701 Pipe for Storm Drains and Culverts.

3.7 IDENTIFICATION

A. Comply with requirements in Item D-701 Pipe Drain for Storm Drains and Culverts for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Test plastic gravity sewer piping according to ASTM F1417.
    b. Test concrete gravity sewer piping according toASTM C1628.

7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.

    a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

8. Manholes: Perform hydraulic test according to ASTM C969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

PART 4 - MEASUREMENT

4.1 **METHOD OF MEASUREMENT**.

A. 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, filter fabric, excavation, backfill and any other incidentals required to install the underdrain trench shall be included in the footage as incidental the pipeline being measured.

Underdrain cleanouts shall be measured per each, to include all incidentals required to complete the item.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT.

A. Payment will be made at the contract unit price per linear foot for pipe underdrains of the type, class, and size designated, installed and accepted by the DEN PM.

B. Payment will be made at the contract unit price per each for underdrain cleanouts, installed and approved by the DEN PM.

C. 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:

221313-5.1 Install 6” SAG cleanout – per each

221313-5.2 Install 6" SAG GI cleanout – per each

221313-5.3 Install 6" SAG GI pipe – per linear foot

END OF SECTION 221313

SECTION 230400
BASIC HVAC REQUIREMENTS

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 if included, apply to this Section.

1.2 SUMMARY

A. Basic requirements common to the work in general of Division 23 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational HVAC systems described and specified under other Sections of this Division 23.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 23 and report any known or observed defects that affect the Work to the General Contractor. Do not proceed with the work until defects are corrected.

1.3 REFERENCES

A. General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable Codes.
2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.
3. When required by individual Specifications Section by means of reference for cleaning or installation requirements, etc., obtain a copy of the standard. Maintain the copy at job site during work until substantial completion. Copy may be in electronic format.
4. Schedule of Referenced Organizations: Reference Section 014200 "References" for a list of the acronyms of organizations referenced in these Specifications.

1.4 DEFINITIONS

A. Conform to Division 01: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. The following words are re-defined and/or elaborated on for the context of Division 23 work:

1. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
2. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.
3. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.
4. General Contractor: The term "General Contractor" used in Division 23 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.

1.5 QUALITY CONTROL

A. Conform to Division 01. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.

B. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the Manufacturer. This includes the performance of tests as recommended by the Manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Comply with latest editions of all applicable Codes, Standards, Ordinances and Regulations in effect as of the date of the Contract Documents adopted by CCD, BD, and FD, including but not necessarily limited to the following:

1. National Electrical Code NFPA-70.
2. NFPA.
3. ASHRAE.
4. SMACNA.
5. Underwriters Laboratories.

B. If discrepancies occur between the Contract Documents and any applicable Codes, Guidelines, Ordinances, Acts, or Standards, the most stringent requirements shall apply.

C. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.7 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions: Refer to Division 01, General Requirements.

B. Some materials and equipment are specified by Manufacturer and catalog numbers. The Manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. When alternate or substitute materials and equipment are used, Contractor shall be responsible for space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use.

D. When providing a product and/or service under the qualification of "acceptable equal," Contractor shall be entirely responsible for additional costs incurred due to modifications to the civil, architectural, structural, mechanical, and electrical design that may be required to accommodate the "acceptable equal."

E. Substitute materials and equipment are only allowed to be provided from the Manufacturers listed as approved.

1.8 SHOP DRAWINGS, PRODUCT DATA, AND AS-BUILT DRAWINGS

A. General: Comply with the General Conditions of the Contract and with Division 01 - General Requirements.

1. All documents shall be submitted in electronic format.
2. All submittals to be provided in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.9 CONTRACT RECORD DOCUMENTS

A. General: Comply with the General Conditions of the Contract and with Division 01 - General Requirements,

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".

1.10 OPERATING AND MAINTENANCE DATA

A. HVAC Contractor shall submit electronic copy containing a single PDF file of the entire maintenance manual to the DIA Project Manager, General Contractor for their approval.

B. All submittals to be provided in accordance with requirements as specified in Section 013300 "Submittal Procedures".

C. The manual shall have:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown.
3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
4. Manufacturer's data on each piece of equipment, including:

    a. Installation instructions.
    b. Drawings and specifications (approved shop drawings).
    c. Parts lists.
    d. Complete wiring and temperature control diagrams (approved shop drawings).

5. Each piece identified on any schedule shall be bookmarked in the electronic file by its scheduled tag ID (IE: AHU-1)

D. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified elsewhere. Insert a copy.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
2. Tag all manual operating valves with 1-1/2" diameter brass tags attached with chains. Tags are to be sequence numbered with legible metal stamps.
3. Provide a typed tag list or schedule mounted under glass in the room designated by DIA Project Manager stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".

E. Division 23 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the DIA Project Manager, and General Contractor far enough in advance so that all personnel can be notified.

F. Division 23 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design.

1.11 FINAL OBSERVATION

A. Comply with the requirements of Division 01 and the following:

1. Prior to the request for final observation, all Work under the contract shall be completed, all systems shall be in proper working order and placed in operation (System Startup of 48 hours).

2. All HVAC systems shall be properly balanced with quantities shown on the Drawings, and all water circuits shall be adjusted to provide the proper flows.
3. All equipment shall be cleaned, including but not limited to, plumbing fixtures. All debris and construction materials shall be removed from the DIA property to a DIA approved landfill off-airport.
4. The temperature control system shall be complete and in proper working order. All instruments shall be properly and accurately field calibrated.
5. At the request of the DIA Project Manager, a representative of the Contractor who is thoroughly familiar with the Project and operation of the various systems shall be present during the final observation to demonstrate proper operation of the equipment and controls. If requested by the DIA Project Manager, the Contractor shall have representatives from his subcontractors present to assist during final observation.

1.12 PROJECT CONDITIONS

A. Accessibility.

1. Division 23 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 23 Contractor shall locate all equipment, which must be serviced, operated, or maintained in fully accessible positions. Such equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the DIA Project Manager prior to making the change.
3. Division 23 Contractor shall provide the General Contractor with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.
4. Provide carpentry, masonry, concrete and metal work required for work of this Division where not specifically called for under other Sections.

B. Fabrication.

1. Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of existing conditions and new Structural and Architectural Work.

C. Freeze Protection.

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting.

1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from

premises when no longer required. Conform to OSHA requirements and standards.

1.13 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Division 21 Fire Suppression, Division 22 Plumbing, Division 26 Electrical, and Division 33 Utilities and other Divisions as required to perform the Work..

C. Existing System Interruptions: Comply with Division 01.

D. Cutting and Patching: in visible areas patch and restore cut surfaces to best match the adjacent surfacing.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural and Engineering Drawings and equipment to be furnished.

F. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the DIA Project Manager and obtain written instructions for any changes necessary.

G. Order of Precedence: The precedence of construction documents are as Specified in the General Conditions.

1.14 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition, which may cause damage to equipment or endanger personnel.

B. Ensure that all control systems are fully operational in automatic mode.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to ensure against accidental operation or operation by unauthorized personnel.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify the DIA Project Manager in writing a minimum of 48 hours prior to start-up of all major mechanical equipment and systems.

F. Should there be any equipment found which had not been properly started up, it will be the responsibility of this Contractor to arrange for the appropriate personnel to start up the equipment at his expense and at a time as scheduled by the DIA Project Manager.

1.15 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 23 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. Notify the DIA Project Manager, DIA Mechanical Inspector and DIA Mechanical Engineer in writing a minimum of 72 hours prior to testing of any mechanical equipment and systems.

D. All testing must be performed in the presence DIA Project Manager and or his designated representative; his signature for verification of the test must appear on the schedule.

E. All testing must be performed in accord with the procedures set forth in Division 23 and other Sections of the Specifications where referenced. At completion of testing, the schedule shall then be submitted in triplicate to the DIA Project Manager.

F. Make all specified tests on piping, ductwork and related systems as necessary.

G. Make sure operational and performance tests are made on seasonal equipment.

H. Complete all tests required by Code Authorities, such as health codes, building codes, and safety codes.

I. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, valve and pump packing properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

1.16 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Requirements of the Contract.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 23 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

C. Clean HVAC Systems in accordance with applicable Division 23 Sections.

1.17 WARRANTIES

A. Conform to Division 1: Provide a written warranty covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of two (2) years after date of acceptance. During this period provide labor and materials as required to repair or provide labor and materials required to repair or replace defects.

B. Provide special warranties for such items of equipment which have or are specified to have warranties in excess of two (2) years.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

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. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 230400

SECTION 230523
VALVES FOR HVAC PIPING

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 if included, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Steel ball valves.
4. Iron ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.1 for power piping valves.
7. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. WATTS.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 STEEL BALL VALVES

A. Steel Ball Valves with Full Port and Stainless-Steel Trim, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Jamesbury; Metso.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 285 psig.
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A216, Type WCB.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

2.4 IRON BALL VALVES

A. Iron Ball Valves, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Apollo Flow Controls; Conbraco Industries, Inc.
c. KITZ Corporation.
d. Sure Flow Equipment Inc.
e. WATTS.

2. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.5 SWING CHECK VALVE

A. Brass Check Valve

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Smith Cooper
b. Jomar
c. Or approved equal.

2. Description

a. Bonnet: Lead Free Brass
b. Pin: Brass
c. Screw: Brass
d. Disc: Lead Free Brass
e. Body: Lead Free Brass

2.6 CIRCUIT SETTER

A. Brass Circuit Setter

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Griswold
b. Bell and Gossett
c. Armstrong
d. Or Approved equal.

2. Description
a. Seat: TFE Rings
b. Body: Brass
c. Drain connection: Brass
d. Readout Valve Ports
e. Memory Stop

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Contractor to coordinate with client or facilities and maintenance to provide proper identification tags and coloring.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 GLYCOL-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: bronze ball valves, two piece with stainless-steel trim, full port,-joint ends.

1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2-1/2 and Larger:

1. Iron ball valves, Class 125.

a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

2. Steel ball valves, Class 150.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT.

A. Valves shall be paid for per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT.

A. Payment for valves shall be made at the contract unit price per each, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

230523-1 Valves – Circuit Setters – per each

230523-2 Valves – Ball Valves – per each

230523-3 Valves – Drain Legs – per each

230523-4 Valves – Check Valves – per each

END OF SECTION 230523

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND 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 if included, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.
5. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

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.

1.8 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with AHJ. Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut Corporation; Tyco International, Ltd.
    g. Wesanco, Inc.
    h. Or approved equal.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.

8. Paint Coating: Epoxy.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.
10. Or approved equal.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig **or** ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coatedsteel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Or approved equal.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ERICO/Michigan Hanger Co.
    b. MIRO Industries.
    c. Portable Pipe Hangers.
    d. Or approved equal.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Portable Pipe Hangers.
    b. Or approved equal.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and

larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal to be coordinated with Client or facilities and maintenance, else match existing.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT APPLICATIONS AND SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and [metal framing systems and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include

auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

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. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 230529

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

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 of the Specifications covers testing and balancing of environmental systems, including, but not limited to distribution systems and the connected equipment and apparatus. The testing and balancing of all environmental systems shall be the responsibility of a single Testing, Adjusting, and Balancing (TAB) firm.

B. Related Work Specified Elsewhere: General Requirements of Division 01 and Section 230400 "Basic Mechanical Requirements," pertain to and are hereby made part of the Work of this section of the Specifications.

C. Section Includes:

1. Balancing, Testing and Adjusting Air Systems:
    a. Constant-volume air systems.
2. Testing, Adjusting, and Balancing Equipment:
    a. Motors.
    b. Heat-transfer coils.
3. Testing, adjusting, and balancing existing systems and equipment.
4. Sound tests.
5. Vibration tests.
6. Control system verification.

D. Related Sections:
1. Section 230400 "Basic Mechanical Requirements".

E. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ALLOWANCES

A. Cash Allowance: Include under provisions of Division 01.

B. Allowance includes testing, adjusting, and balancing of mechanical systems. Work is included in this section and is part of the Contract Sum/Price.

1.4 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. AABC: Associated Air Balance Council.

C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. BAS: Building automation systems.

F. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

G. NC: Noise criteria.

H. NEBB: National Environmental Balancing Bureau.

I. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

J. RC: Room criteria.

K. Report Forms: Test data sheets for recording test data in logical order.

L. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

M. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

N. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

O. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

P. TAB: Testing, adjusting, and balancing.

Q. TABB: Testing, Adjusting, and Balancing Bureau.

R. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

S. TDH: Total dynamic head.

T. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

U. Test: A procedure to determine quantitative performance of systems or equipment.

V. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.5 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 014225 "Referenced Standards" for listing of issuing organizations or agencies.

B. Applicable Standards:

1. Associated Air Balance Council (AABC):

   a. National Standards for Total System Balance.

2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

   a. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

3. International Building Code (IBC) with the Denver Amendments.
4. International Fire Code (IFC) with the Denver Amendments.
5. National Environmental Balancing Bureau (NEBB):

   a. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

6. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):

   a. HVAC Systems Testing, Adjusting, and Balancing.

1.6 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice to DEN Project Manager of scheduled meeting time and location, with meeting to convene minimum one (1) week prior to commencing work of this Section.

B. Attendance shall include representatives of all systems and equipment Installers having performed, or in the process of performing, project work subject to testing, balancing, and adjustment by the TAB firm.

C. Conference agenda shall include review of status of installation and completion of each system requiring testing balancing and adjusting, for the purpose of confirming that the schedule of work to be performed will be planned so as to ensure readiness of systems.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.7 ACTION SUBMITTALS

A. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract to ensure that the TAB firm has met the requirements this section of the Specifications and is on the Project from the outset of construction.

B. All TAB submittals shall be electronically submitted in PDF format to the DEN Project Manager and directly to the DEN Mechanical Engineer.

C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

E. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for DEN Project Manager and for inclusion in operating and maintenance manuals.

F. Include detailed procedures, agenda, sample report forms prior to commencing system balance.

G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, NEBB or TABB forms. When necessary, supplement with forms containing information indicated in Schedules.

Items should only be deleted for equipment that is not included in the Project.

H. Final Report: At least fifteen (15) days prior to Contractor's request for final inspection, submit in letter size, a single PDF file of the final test report on applicable reporting forms for review. Each individual final reporting form must bear the signature of the person who recorded data and that of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include all items listed in PART 3- Execution.

I. A statement outlining all abnormal or notable conditions not covered in above data.

J. Proposed resolutions to equipment that is performing outside of the specified performance ranges.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.9 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".

1.10 QUALITY ASSURANCE

Expand indicating responsibilities under the contract.

A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

B. TAB Specialists Qualifications: Certified by NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.11 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Notify the DEN Project Manager, DEN Mechanical Inspector and DEN Mechanical Engineer in writing a minimum of 72 hours prior to testing of any equipment and/or systems. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.12 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.13 WARRANTY

A. Warranty of all equipment described in this Section shall meet warranty requirements of Section 017835 "Warranties and Bonds" and Section 230400 "Basic HVAC Requirements".

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Duration of Guarantee shall be 365 days. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:

1. Able Balance Corp.
2. Griffith Engineering Service.

3. Jedi Balancing, Inc.
4. JPG Engineering, Inc.
5. TAB Services, Inc.
6. or approved equal.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. Ensure the Following Conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Air coil fins are cleaned and combed.
6. Hydronic systems are flushed, filled, and vented.
7.
8. Proper strainer baskets are clean and in place.
9. Service and balance valves are open.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to DEN Project Manager to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

C. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

D. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.4 TEMPERATURE CONTROLS

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high-temperature and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

L. Velocity pressure sensor is receiving the proper signal and is then sending that signal to the regulator.

M. Primary air damper will allow design flows without going to end point settings.

N. Thermostats are calibrated.

O. Control pressure is compatible with the primary damper motor range, dead band range and heating electric P.E. or valve motor range.

P. Direct acting or reverse acting controls are properly installed.

Q. Primary fan static pressure controls are receiving the proper signal in their installed location and transmitting this signal to the fan controller.

R. Include a written certificate (include in balance report) that the above items are functioning properly.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts. Restore vapor barrier and finish according to insulation Specifications for this Project.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is properly sealed.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5%.

B. Prepare schematic diagrams of systems' "as-constructed" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check expansion tank liquid level.
   3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation and set at indicated flow.
   5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
   6. Set system controls so automatic valves are wide open to heat exchangers.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5% of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5% greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Phase and hertz.
6. Nameplate and measured voltage, each phase.
7. Nameplate and measured amperage, each phase.
8. Starter size and thermal-protection-element rating.
9. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test manual bypass of controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.11 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the aircraft or jetway boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure, adjust, and record the pressurization of each room, each zone, and each aircraft or jetway by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over-pressurization and under-pressurization, and observe and report on the system's ability to revert to the set point.
3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.12 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Hydronic Systems with Meters: Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. On completion of the balance, the following information shall be recorded in the report: Flow meter or calibrated valve size and brand, required flow rate and pressure drop, valve settings on meters or valves with a readable scale, flow rate in both full coil flow and full bypass modes.

C. Hydronic Systems Without Meters: Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system. On completion of the balance the following information shall be recorded in the report:

1. Design entering and leaving water temperature/pressure drop.
2. Final balance entering and leaving water temperature/pressure drop.

D. The hydronic system(s) shall be balanced being certain that the path to one terminal is fully open. Total system flow shall be adjusted at pump by restricting the discharge balance valve. Indicate final valve position on report.

E. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

F. Effect system balance with automatic control valves fully open to heat transfer elements. Control valve bypass loops shall be set with the balancing valve to provide equal flow in either mode. Confirm in writing.

G. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

H. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.13 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Before any demolition work or duct work alterations are made, measure airflow, temperature, static pressure and electrical measurements on main equipment serving the branch line.

B. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

C. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

D. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

E. After all branch line ductwork modifications are complete and TAB services have been performed, measure airflow, temperature, static pressure and electrical measurements on main equipment serving the branch line.

3.15 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Glycol-Water Flow Rate: Zero to plus 10 percent.
2. Cooling-Water Flow Rate: Zero to plus 5 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

C. Supply, return and exhaust air flow rate tolerances shall be identical for each system. (IE: If an AHU is balanced to 97% of design air flow rate, the corresponding exhaust fan should match this 97% tolerance.)

3.16 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the DEN Project Manager.

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.17 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems

balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. PCA Units (waterside only)
2. Plumbing Pumps
3. HVAC Pumps

3.19 MOTOR STARTERS AND THERMAL HEATERS

A. Not used

3.20 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.

8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Final performance percentage of design performance.
    c. Equipment system or zone service.
    d. Notable characteristics of systems.
    e. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. A set of contract document drawings indicating 'as-built' conditions shall be included in the report with all terminals (outlets, inlets, coils, unit heaters, etc.) and thermostat locations clearly marked and all equipment designated. Locations of all tests shall be clearly indicated.
14. Data for terminal units, including manufacturer's name, type, size, and fittings.
15. Notes to explain why certain final data in the body of reports vary from indicated values and proposed resolutions for equipment measured outside of the acceptable specified ranges.
16. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Balancing stations.
6. Position of balancing devices.

E. Equipment measurements shall include the following information.

1. Instrument list including instrument, manufacturer, model, serial number, range, calibration date.
2. Data to be submitted for systems having electric motor drives, except as otherwise indicated, shall in all cases include the following to the extent applicable:

    a. Electric Motor data including manufacturer, HP, Voltage, phase, amperage (name plate, actual (in all operating modes), no load), service factor, efficiency, power factor, starter size (brand, model, enclosure type, installed thermal heaters and the rating of the heaters, required thermal heaters and the rating of the heaters if different than installed).

b. For motors controlled by variable frequency controllers, test data shall include amperage at one-third, two-thirds, and full speed motor RPM.

3. Static pressure across each individual component of the system and the total system.
4. Coil data including identification/number, location, service, manufacturer, air flow (specified and actual), water flow (specified and actual), water pressure drop (specified and actual), entering and leaving water temperatures (specified and actual), entering and leaving air temperatures (specified and actual), air pressure drop (specified and actual).
5. Flow Measuring Station and Calibrated Balancing Valve data including identification, location, size, manufacturer, model, flow rate (specified and actual), pressure drop (specified and actual), station or valve calibrated setting.
6. Measurement of existing equipment data prior to new work start.

    a. Date of test on original equipment
    b. Equipment tag
    c. Inlet static pressure (inches WC)
    d. Outlet static pressure (inches WC)
    e. Outlet airflow (CFM)
    f. Coil entering air and water temperatures (F).
    g. Coil leaving air and water temperatures (F).
    h. Motor electrical data, HP, voltage and amperage at test time.

7. Measurement of existing equipment data upon completion of new work.

    a. Date of test on original equipment
    b. Equipment tag
    c. Inlet static pressure (inches WC)
    d. Outlet static pressure (inches WC)
    e. Outlet airflow (CFM)
    f. Coil entering air and water temperatures (F).
    g. Coil leaving air and water temperatures (F).
    h. Motor electrical data, HP, voltage and amperage at test time.

8. Instrument Calibration Reports:

    a. Report Data:

        1) Instrument type and make.
        2) Serial number.
        3) Application.
        4) Dates of use.
        5) Dates of calibration.

9. Measurements outside of tolerance: If the final measurements differ from the design measurements in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED." TAB firm shall provide recommendations and/or solutions for resolving all FAILED measurements.

F. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.

d. Make and model number.
e. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Water flow rate in gpm.
b. Water pressure differential in feet of head or psig.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.

G. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.21 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

F. Prepare test and inspection reports.

3.22 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

    a. Measure airflow of at least 10% of air outlets.
    b. Measure water flow of at least 5% of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Measure sound levels at two locations.
    e. Measure space pressure of at least 10% of locations.
    f. Verify that balancing devices are marked with final balance position.
    g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by DEN Project Manager, DEN Mechanical Engineer or their designated representative(s).
2. TAB firm test and balance engineer shall conduct the inspection in the presence of DEN Project Manager, DEN Mechanical Engineer or their designated representative(s).
3. DEN Project Manager, DEN Mechanical Engineer or their designated representative(s) shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10% of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.23 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

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. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 230593

SECTION 230719
HVAC PIPING INSULATION

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 if included, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Cooling chilled-water piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Submit product description, list of materials and thickness for each service, and locations. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any) for each type of product indicated.

   1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with AHJ. Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements stated in 2021 IECC Section C403.

Pipe Insulation shall meet the requirements of 2021 IECC Section 403.12.3. Shall meet or exceed insulation thickness and conductivity requirements stated 2021 IECC Table 403.12.3. Optionally, provide insulation with equivalent or greater R-value.

R-value can be calculated by taking the thickness in inches and dividing it by conductivity in Btu*in/(h*ft2*°F).

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Industrial Insulation Group (IIG); Thermo-12 Gold.
b. or approved equal.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
d. or approved equal.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
f. or approved equal.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Knauf Insulation; Permawick Pipe Insulation.
b. Owens Corning; VaporWick Pipe Insulation.
c. or approved equal.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II

or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; CrimpWrap.
    b. Johns Manville; MicroFlex.
    c. Knauf Insulation; Pipe and Tank Insulation.
    d. Manson Insulation Inc.; AK Flex.
    e. Owens Corning; Fiberglas Pipe and Tank Insulation.
    f. or approved equal.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA, Inc.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    d. K-Flex USA; R-373 Contact Adhesive.
    e. or approved equal.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    d. Mon-Eco Industries, Inc.; 22-25.
    e. or approved equal.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.
   e. or approved equal.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.
   e. or approved equal.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.
   c. or approved equal.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    b. Eagle Bridges - Marathon Industries; 501.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    d. Mon-Eco Industries, Inc.; 55-10.
    e. or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    b. Eagle Bridges - Marathon Industries; 570.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
    d. Or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.
    f. or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.
    d. or approved equal.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.
    f. or approved equal.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. or approved equal.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. or approved equal.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. or approved equal.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
        2) or approved equal.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
        2) or approved equal.

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
        2) or approved equal.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.
e. Or approved equal.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by DEN Project Manager.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.
d. Or approved equal.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

a. Sheet and roll stock ready for shop or field sizing.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: [1-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
b. Or approved equal.

F. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
b. Or approved equal.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
e. Or approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   e. Or approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
   d. Or approved equal.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
   e. Or approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
b. Or approved equal.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
c. or approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.
b. Or approved equal.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

3.2 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

I. Keep insulation materials dry during application and finishing.

J. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

K. Install insulation with least number of joints practical.

L. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

N. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

P. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Circumferential joints: Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Longitudinal seams: Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.
    b. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

T. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.5 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Install materials in accordance with manufacturer's instructions and N.I.C.A. standards.

B. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

C. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

D. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

E. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have standard jackets, with vapor barrier, factory-applied or field-applied. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets may be used if in accordance with specified flame spread and smoke developed limitations.

B. Indoor, Concealed Applications: Insulated dual-temperature pipes or pipes conveying fluids below ambient temperature shall have vapor barrier jackets, factory-applied or field-applied. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with glass cloth and vapor barrier adhesive.

C. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with reinforced white kraft and aluminum foil laminates. Do not use PVC jackets.

D. Exterior Applications: Provide vapor barrier jackets. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement.

E. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

F. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

G. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

H. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

I. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

J. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.11 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system as required by client, else match existing.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by DEN Project Manager. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by DEN Project Manager, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. PCA Dual-Service Heating and Cooling, 40 to 200 Deg F:

1. NPS 12 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. PCA Dual-Service Heating and Cooling:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
1. Aluminum, Stucco Embossed: 0.024 inch thick.
2. Painted Aluminum, Stucco Embossed: 0.024 inch thick.

D. Piping, Exposed:
1. Aluminum, Stucco Embossed: 0.024 inch thick.
2. Painted Aluminum, Stucco Embossed: 0.024 inch thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
1. Aluminum, Stucco Embossed: 0.020 inch thick.

D. Piping, Exposed:
1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

PART 4 - MEASUREMENT

4.1 **METHOD OF MEASUREMENT**.

A. The insulation shall be paid for per linear foot, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 **METHOD OF PAYMENT**.

A. Payment for insulation shall be made at the contract unit price per linear foot, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

230719-1 Insulation for 1-1/2" Piping – per linear foot

END OF SECTION 230719

SECTION 232113
HYDRONIC PIPING

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 pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.

1.3 ACTION SUBMITTALS

A. Product Data: Include data on pipe materials, pipe fittings, and accessories. Provide manufacturers catalogue information. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves. Include the following:
1. RTRP and RTRF with adhesive.
2. Pressure-seal fittings.
3. Chemical treatment.
4. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates. Include welders certification of compliance with ASME SEC 9 AWS D1.1..

D. Pneumatic Leak Test:

1. Contractor shall submit drawings and procedures of the pneumatic leak test to the DEN Project Manager no later than two (2) weeks prior to testing. Contractor may not proceed with tests unless approved in writing by the DEN Project Manager.

E. Field Quality Control Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work.

1. Record actual locations of valves, piping and anchors.

C. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. Drawings to be submitted in current DEN approved format as per requirements of Division 01. Other file formats will not be accepted.

1.6 EXTRA STOCK

A. Provide two (2) repacking kits for each size and valve type.

1.7 QUALITY ASSURANCE

A. Manufacture: Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

B. Manufacturer's Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

C. Installer Qualifications:

1. Installer: Company specializing in performing the Work of this Section with minimum five (5) years documented experience.
2. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
3. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

D. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 230400 "Basic HVAC Requirements" Division 01 requirements.

B. Accept components on site in shipping containers with labeling in place. Inspect for damage. Collect and save installation instructions for DEN Project Manager's use.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with AHJ. Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
1. Dual-Temperature Heating and Cooling Glycol Piping: 150 psig at 200 deg F.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. NIBCO INC.
   b. Viega.
   c. or approved equal.

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.

D. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Victaulic Company.

b. Or approved equal.

2. Housing: Steel.
3. O-Rings and Pipe Stop: EPDM.
4. Tools: Manufacturer's special tool.
5. Minimum 300-psig working-pressure rating at 230 deg F.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 Flexible Glycol Hose

A. Flexible Hose: Nitrile synthetic rubber ARPM Class A with synthetic rubber cover. Reinforced with spiral-plied synthetic fabric with wire. Contractor to check and provide appropriate coupling for flexible hose attachments. Minimum temperature rating of -35 to 200 degrees F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Continental; Model Flexwing Petroleum.
Or approved equal.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. A.Y. McDonald Mfg. Co.
   b. Capitol Manufacturing Company.
   c. Central Plastics Company.
   d. Hart Industries International, Inc.
   e. Jomar International, Ltd.
   f. Matco-Norca.
   g. Watts Regulator Co.
   h. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
   i. Or approved equal.

2. Description:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts Regulator Co.
   e. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
   f. Or approved equal.

2. Description:

   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 125 psig minimum at 180 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.
e. Or approved equal.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elster Perfection.
b. Grinnell Mechanical Products.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.
f. Or approved equal.

2. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

3.2 GENERAL

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded connections to valves, equipment or other apparatus.

C. Use non-conducting dielectric waterway fittings or insulating flanges whenever jointing dissimilar metals in piping systems. Dielectric fittings shall have end connections that match the adjoining pipe.

D. Provide pipe hangers and supports in accordance with ASTM B31.9 or MSS SP69 unless

indicated otherwise.

E. Use ball or butterfly valves for shut off and to isolate equipment, part of systems, or vertical risers.

F. Use globe, ball or butterfly valves for throttling, bypass, or manual flow control services.

G. Use plug cocks for throttling service. Use non lubricated plug cocks only when shut off or isolating valves are also provided.

H. Use butterfly valves in heating water systems interchangeably with gate and globe valves.

I. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.

J. Butterfly valves shall be lug type.

K. Use 3/4 inch ball valves with cap for drains at main shut off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

3.3 PIPING APPLICATIONS

A. Dual-temperature heating and cooling glycol piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe fittings, flange fittings, and threaded joints.

B. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40 or STD Schedule steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3.4 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install shutoff valve immediately upstream of each dielectric fitting.

R. Coordinate with Client or Facilities for pipe identification and tagging.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

3.6 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.7 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.8 FLANGES, UNIONS, COUPLINGS, AND MECHANICAL JOINT RESTRAINTS

A. Unions for Pipe 2 Inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 Inches:

1. Ferrous Piping: 150 psig forged steel, slip on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick non-asbestos preformed gaskets, aramid fibers with nitrile (NBR) binder; Durlon "8500 Green", Garlock "IFG 5500", or approved equal.

C. Dielectric Waterway Fittings: Dielectric fittings designed to effectively separate dissimilar metals exposed to water or other electrolytes, conforming to NSF and ASTM F492 standards for continuous use at temperatures up to 225 degrees F and pressures up to 300 psi. Fittings to have electro-zinc-plated steel casings providing for maintained exterior electrical continuity, threaded ends as applicable, and inert linings. Provide "ClearFlow" units as manufactured by Perfection Corporation or approved substitute.

D. Mechanical Joint Restraints for Ductile Iron Pipe: Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Flexibility of the joint shall be maintained after burial. Glands shall be manufactured of ductile iron conforming to ASTM A 536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA A21.11 and AWWA C153/A21.53 of latest revision. Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1 and shall be EBAA Iron, Inc. SERIES 1100 MEGALUG or equal.

3.9 INSULATING JOINTS

A. Insulating joint assemblies shall conform to the following requirements:

1. Flanged joints shall include full face insulating gaskets, insulating bolt sleeves and double quantity of insulating washers and stainless steel washers.
2. Insulating materials shall be as follows:

   a. Gasket: NEMA Grade G10 retainer conforming to ASTM D 229 with Teflon ring seal on each side of the retainer. Minimum dielectric strength shall be 500 volts per mil (VPM). Compressive strength shall be 50,000 psi. Water absorption shall be 0.05 percent (max.)
   b. Sleeves: Shall be 1/32-inch wall thickness, length to suit two class 150 lb. weld neck flanges, insulating gaskets and valve body thickness. Sleeve shall provide "full" insulation of studs; minimum dielectric strength shall be 500 VPM. Material shall be NEMA Grade G10.
   c. Insulating washers: NEMA Grade G10, 1/8-inch thick (minimum).

B. Install insulating joints at the locations indicated on the drawings. Where not shown on the drawings, they shall be installed within 24 inches of the location at which underground piping transitions to above-ground or within-structure extension.

C. Insulating assemblies shall provide a minimum resistance of 500,000 ohms when tested in the dry condition.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections where needed.

3.11 CLEANING, FLUSHING, AND INSPECTING

A. Clean and flush system, with clear water, of all dirt, metal chips, sand, and foreign matter. After flushing, remove, clean, and replace all strainer baskets or screens. Inspect each run of each system for completion of joints, supports, accessory items, and obvious leaks.

B. Examine and inspect piping in accordance with ANSI B31.1, Chapter VI.

3.12 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Leak Testing:

1. Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, wherever feasible, and remove control devices before testing. Subject entire piping systems to leak tests, either as a whole, or in sections; but leave no part untested.
2. Test gauges shall have a range that provide for the test pressure to be in the middle third of the gauge scale.
3. Contractor shall provide written notification to the DEN Project Manager and DEN Inspector at least 48 hours before performing leak test. Perform all tests in the presence of the authorized City representative.
4. Hydrostatic Leak Test:

    a. Perform hydrostatic leak test on all piping systems.
    b. Hydrostatic Leak Test Procedure:

        1) Leak test procedures shall comply with ASME B31.9.
        2) Fill piping systems with clear water, vent all air, and pressurize at 110% of operating pressure, (but not less than 100 psi) for 1 hour. Test fails if leakage is observed, or pressure drop exceeds 5% of test pressure.

5. Pneumatic Leak Test:

    a. General: Pneumatic leak tests shall only be used on piping with restricted access, under freezing conditions, or where water leakage would damage critical DEN operational equipment. Contractor shall submit a written request for test in accordance with the Submittals paragraphs of this specification Section.
    b. Pneumatic Test Procedure:

        1) Contractor shall submit safety plan for pneumatic testing prior to test.
        2) General: Compressed gas poses the risk of sudden release of stored energy. For that reason, pneumatic testing shall be used only within the following limitations.

            a) The piping system does not contain cast iron pipe or plastic pipe subject to brittle failure.
            b) The system does not contain soldered or solvent cement joints over NPS 2.
            c) The test pressure does not exceed 150 psig.

        3) Test Medium: The gas shall be nonflammable and nontoxic.
        4) Preliminary Test: Prior to application of full pneumatic test pressure, a preliminary test of not more than 10 psig shall be applied to reveal possible major leaks. Pneumatic Test Pressure:

a) Except as limited in 2) below, the test pressure shall not exceed 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium at each stage.
b) The test pressure shall not exceed the maximum allowable pneumatic test pressure for any vessel, pump, valve, or other component in the system under test.

5) Examination for Leakage: After the preliminary test, pressure shall be raised in stages of not more than 25% up to full pneumatic test pressure, allowing time for equalization of strains and detection of major leaks at each stage. Following the application of test pressure for at least 10 minutes, the pressure may be reduced to design pressure and examination shall be made for leakage of the piping. Leaks may be detected by soap bubble, halogen gas, scented gas, test gage monitoring, ultrasonic, or other suitable means. If leaks are found, pressure shall be vented, appropriate repair or replacement shall be made, and the pneumatic test repeated until no leakage is found.
6) Contractor shall measure the surface temperature of the pipe for the duration of testing. The pneumatic test will be deemed successful only when the test pressure can be held at a constant pipe surface temperature for a period of no less than 10 continuous minutes. Record of the pipe temperatures and pressures during the duration of the test shall be submitted to the DEN Project Manager following completion of the test.

6. Testing shall be witnessed by DEN Mechanical Inspector and DEN Project Manager or Designated Representative.
7. Repair piping systems which fail required piping test, by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
8. Drain test water from piping systems after testing and repair work that has been completed.
9. Prepare written report of testing procedures and result.

D. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

A. The piping shall be paid for per linear foot, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. Payment for piping shall be made at the contract unit price per linear foot, for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and for all removal, storage, preparation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

232113-1 CU, Type L Glycol 1-1/2" Piping (CWHS & CWHR Sum) – per linear foot

232113-2 Flexible Hose Glycol Piping – per linear foot

END OF SECTION 232113

SECTION 260100

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 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 percent of panel capacity, including main panel capacity, shall remain as spare capacity after project completion.

C. Where existing panels are used for additional work, when six (6) or less spaces remain a new panel shall be installed.

D. All electrical/electronic circuits, including audio, video and fire alarm systems, shall be in an approved raceway system. No “wild circuits” will be accepted.

E. The Designer of Record shall not design or specify and the Contractor shall not install rigid metal conduit, electrical metallic tubing, flexible steel conduit, liquid-tight flexible steel conduit, non-metallic rigid conduit or innerduct in any horizontal or vertical concrete wall or slab structures or portions thereof, e.g., cast-in-place concrete floor slab on steel decking; cast-in-place concrete slabs integral with concrete structural support systems; prestressed concrete slabs; post-tensioned concrete slabs; precast concrete construction with or without field applied or plant fabricated concrete topping slabs, slabs on grade, foundation walls or in concrete cast-in-place walls, etc.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. General Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 - General Requirements.

B. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 26.

C. 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.

D. Temporary Power: See Division 01 for construction power constraints.

1.04 REFERENCE STANDARDS

A. 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.

B. Latest editions of the following:

1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Code).
2. Uniform Fire Code (as amended by the Denver Fire Department).
3. ANSI/IEEE C2 - National Electrical Safety Code.
4. OSHA - Occupational Safety and Health Administration, as Amended
5. Underwriter's Laboratory (UL)
6. National Fire Protection Association (NFPA)
7. Other references as listed elsewhere in these specifications.
8. IEEE standard 519- recommended practices and requirement for harmonic control in electrical power systems.

1.05 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 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. “DEN Project Manager” or “Project Manager”: Refers to individual authorized to make decisions on the behalf of the City and County of Denver, and are used interchangeably in these specifications.

Q. “ROCIP”: Rolling Owner Controlled Insurance Program arranged by City and County of Denver to ensure pro-active safety process are used. Includes ROCIP Safety Manual.

R. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this project.

1.06 WORK SEQUENCE

A. Construct Work in sequence under provisions of Division 01 where applicable.

1.07 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 Project Manager in writing 72 hours before the date of bid opening.

D. In the event such discrepancies exist, and the Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the Project Manager.

1.08 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 Project Manager. The contractor shall submit shop drawings of any saw cutting or core drilling to the Project Manager prior to performing the work.

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 Project Manager two weeks prior to the shutdown.

1.09 COORDINATION DRAWING

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. 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.

1.10 SUBMITTALS (REFER TO SECTIONS 013300 AND 013325)

A. 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.

B. 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.

C. 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

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.

E. Contractor agrees that submittals processed by the Project Manager are not change orders; that the purpose of submittals is to demonstrate to the Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material he intends to furnish and install and by detailing the installation methods he intends to use.

F. Contractor shall be responsible for dimensions (which he shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of his 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 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 Project Manager accepting their use.

I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this project.

1.11 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 Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Project Manager. Follow DEN CADD standards, to be furnished to the successful bidder. 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.

1.12 REGULATORY REQUIREMENTS

A. Obtain and pay for 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.

1.13 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 -30ºF to 120ºF

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

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 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.

2.02 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.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards.

B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named with supporting documentation.

2.04 PRODUCTS LIST

A. Within 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.

2.05 SUBSTITUTIONS

A. Refer to Division 01 - General Requirements, Section 012510, Substitutions.

2.06 GUARANTEE

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 years, or any longer period specifically noted elsewhere in these specifications, from date of final acceptance.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of work, as determined by the Project Manager, is 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 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.

3.02 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 Project Manager.

B. All openings made in fire-rated walls, floors, or ceilings shall be sealed and made tight in a manner to conform to the fire rating for the barrier penetrated.

C. 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.

3.03 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.

3.04 PROGRESS OF WORK

A. Order 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 this Division shall be borne by the Contractor.

3.05 ELECTRICAL COMPLETION

A. Indoctrination 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.

Systems	Hours of Instruction
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B. Operating and Maintenance Manuals and Parts Lists: Deliver three complete operating and maintenance manuals and parts lists in three ring binders to the Owner at the time of the above required indoctrination. The information shall be provided on the manufacturer's original data sheets. Fully explain the contents of the manuals as part of required indoctrination 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 contracts. Submit three copies of test reports to the Project Manager for his 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, 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 clean-up 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 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.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement for payment shall be made for electrical demolition or installations, unless otherwise indicated herein. Electrical demolition and installation shall be considered incidental to the associated contract per each price.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment shall be made for electrical demolition or installation, unless otherwise indicated herein. Electrical demolition and installation shall be considered incidental to the associated contract per each price.

END OF SECTION 260100

SECTION 260505

SELECTIVE DEMOLITION FOR ELECTRICAL

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 RELATED SECTIONS

A. Section 011100 "Summary of Work" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.

B. Item P-101 “Surface Prep” for demolition and removal of selected site elements.

C. Section 260100 "General Electrical Requirements."

1.03 ALTERNATES

A. Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

PART 2 - PRODUCTS

2.01 EQUIPMENT

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 PROCEDURES

A. Existing electrical systems shall not be abandoned in place.

B. No area; new, remodeled, or existing shall be without a fully operational electrical system, except for scheduled outages.

C. The contractor shall remove, relocate or replace any electrical equipment or systems as required for installation of any structural, mechanical or plumbing equipment,

D. Maintain all existing electrical, control, communication, and signaling systems to the extent required by the Owner.

E. Maintain all existing electrical, control, communication, and signaling systems to the extent required by the Owner.

F. Where remodel or demolition interferes with circuits outside of the work area, schedule outages to rework the circuits as required.

G. All items that are removed and not designated by the Project Manager to be used or turned over to the owner shall be removed from the airport.

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 associated equipment demolition scope of work.

END OF SECTION 260505

SECTION 260510

TESTING, ACCEPTANCES AND CERTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 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.

1.03 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.
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.

1.04 SUBMITTALS

A. Comply with Division 01 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.
5. Generator load bank test report.
6. Transfer Switch test report.
7. Load balance report for each switch board, panel board and switch gear.

PART 2 PRODUCTS

2.01 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.

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 of replacement.

C. A retest to demonstrate the equipment will meet the requirements of the Contract Documents shall be scheduled with the DEN Project Manager.

2.02 ENGINE GENERATOR SYSTEM (WHEN FURNISHED AND INSTALLED AS PART OF THIS CONTRACT).

A. Test generator operation per tests as specified in Section 263213 "Engine Generators".

2.03 BYPASS ISOLATION TRANSFER SWITCH (WHEN FURNISHED AND INSTALLED AS PART OF THIS CONTRACT).

A. Test transfer switch operation per tests as specified in Section 263600 "Transfer Switches".

2.04 HVAC

A. Test the operation of all heaters and air conditioners.

B. Test the Lead Lag Control circuits.

2.05 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.

2.06 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. Insulation test values shall meet or exceed the values given below:

Conductor Size: (AWG or KCMIL)	**Resistance:** (Megaohms - 1,000 ft.)
12-8	200
6-2/0	100
3/0-750	100

PART 3 - EXECUTION

3.01 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 Inspector.

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 associated equipment installation scope of work.

END OF SECTION 260510

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include data substantiating that materials comply with requirements.

1.05 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".

1.06 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

1.07 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

2.01 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Southwire Company.
4. Encore Wire Corp.
5. Cerro Wire and Cable Company.
6. CME Wire.
7. Coleman Cable Inc.
8. Or approved equal.

B. All conductors shall be copper.

C. AC cable and Modular wiring are not permitted.

D. MC Cable: Comply with NEMA WC 70. Provide internal equipment grounding conductor throughout.

E. Copper Conductors: Comply with NEMA WC 70.

F. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, or XHHW.

G. Remote Control and Signal Cable

1. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated at 60 deg C, individual conductors twisted together, shielded, and covered with a PVC jacket.
2. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

2.02 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.
6. Ideal.
7. Or approved equal.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger, except for connection to vibrating equipment then stranded shall be used.

C. Prohibited Cable Types: UF, NM, SE, AC.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Minimum wire size shall be based on the over current protection device and as governed by the NEC.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Coordinate first paragraph below with Division 26 Section "Underground Ducts and Raceways for Electrical Systems."

D. Feeders below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Class 1 Remote Control and Signal Circuits: Type THHN-THWN, in raceway or cable tray as applicable, or Copper conductor, 600 volt insulation, individual conductors twisted together, shielded, and covered with a PVC jacket.

I. Class 2 Remote Control and Signal Circuits: Type THHN-THWN, in raceway or cable tray as applicable, or Copper conductor, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

J. All power, control, data, communication and signal wire or cable shall be installed in an approved raceway.

K. MC Cable allowed for use in 20-Ampere branch circuits, with the following conditions:

1. Cable shall be run concealed in all locations. Where circuiting must be exposed, provide single conductor building wire in approved raceway.

2. Home run from first device to panel board shall be single conductor building wire in approved raceway.
3. MC cable shall be supported using approved methods throughout. Do not run cables unsupported in any area, including above accessible ceilings, in unfinished areas, etc.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. All power, control, data, communication and signal wire or cable shall be installed in an approved raceway (raceway shall be defined as conduit or cable tray as applicable).

B. Verify raceways are open, continuous and clear of debris before installing cables.

C. Pull all conductors into a raceway at the same time. Use a listed wire pulling lubricant for pulling No. 4 AWG and larger wires.

D. Completely and thoroughly swab raceway system before installing conductors for conduit in floors, concrete, or below grade.

E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

F. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

H. 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.

I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

J. Neatly train wiring inside boxes, equipment, and panel boards. Make temporary connections to panel board devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.

K. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

L. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

M. Conductors shall not be pulled in concrete encased conduits before concrete is placed.

N. For connection to vibrating equipment, stranded wire shall be used.

O. All wiring shall be installed in a new approved raceway system. Existing conduits shall not be used unless approved by the DEN Project Manager.

P. Where harmonic currents exist on feeders that supply panelboards that serve electronic equipment of 40 percent or more of the panelboards total ampacity, two (2) full size neutral conductors or a neutral conductor rated at 200 percent shall be provided to the panelboard being served. A neutral bus bar rated at 200 percent shall also be provided in the panelboard.

Q. Shared Neutrals: Prohibited. A full-size neutral conductor shall be provided for each single-phase circuit.

3.04 CONNECTIONS

A. 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 and UL 486B.

B. Splice only in accessible junction and outlet boxes.

C. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.05 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Field inspection and testing will be performed under provisions of Division 01.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
    a. Prior to energizing, all building service cables, feeders to and/or from transformers, switchboards and panel boards are to be tested with a 500-volt insulation megohm meter to determine insulation resistance levels. 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 for one minute between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. Insulation test values shall meet or exceed the values given below.

Conductor Size (AWG or KCMIL):	Resistance (Megaohms-1,000 ft):
12-8	200
6-2/0	100
3/0-750	100

3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice eleven (11) months after date of Substantial Completion.
   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
4. Inspect wire and cable for physical damage and proper connection.

B. Test and Inspection Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

D. Cables will be considered defective if they do not pass tests and inspections.

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 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 associated equipment installation scope of work.

END OF SECTION 260519

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Power system grounding.

B. Communication system grounding.

C. Electrical equipment and raceway grounding and bonding.

D. Perimeter ground loop.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. With the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. NFPA Compliance: NFPA 70 "National Electrical Code (NEC)," as adopted and amended by the Denver Building Code, Chapter 10.

C. UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors." Grounding and bonding products shall be UL-listed and labeled for the use.

D. IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.04 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 referenced ground plate in the electrical room.

D. Provide communications system with a # 6 copper grounding conductor at point of service entrance and connect to nearest referenced ground plate.

E. Bond together at a service and at a separately derived systems; neutral conductor, equipment enclosures, all non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, and grounding electrode connector.

F. Provide a 2/0 minimum building perimeter-grounding conductor buried thirty inches (30 inches) below finished grade thirty-six inches (36 inches) from foundation. Install a 3/4” x 10 foot copper clad ground rod at each corner, each change of direction and at intervals not to exceed one hundred feet.

G. Provide a minimum of three inch by twelve inch by one-quarter inch (3” x 12” x 1/4”) copper ground bar in the electrical room for connecting the grounding systems.

H. 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.

1.05 SUBMITTALS (REFER TO SECTIONS 013300 AND 013325)

A. Submit shop drawings under provisions of Section 013325 "Shop and Working Drawings, Product Data, and Samples."

B. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.

C. Submit all field test reports.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ground Rods: Copper-clad steel, 3/4-inch diameter, and minimum length of 10 feet; in manholes ground rods shall be stainless steel 3/4-inch diameter and a minimum length of 10 feet.

B. Grounding Connection Accessories: Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.

C. 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. All ground wires shall be copper except where stainless steel is specified for manholes, sized according to the NEC or as shown on the drawings which ever is larger.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide a separate, insulated, equipment-grounding conductor in all branch circuit conduits.

B. Supplementary Grounding Electrode: Use grounding mats, where indicated, or driven ground rods. Install ground rods in suitable recessed well; fill with gravel after connection is made.

C. Provide a No. 6 AWG and ground plate to each Communications Room or board. Connect to nearest Electrical Room ground plate.

D. Provide isolated and insulated ground conductors for all microprocessor and data processing equipment.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

F. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings, including flexible steel conduit used as expansion fittings.

G. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed.

H. All continuous runs of cable tray and all isolated sections of cable tray shall be bonded and grounded.

I. Provide an equipment-grounding conductor in all conduits.

J. A non-continuous metallic raceway enclosing the service grounding electrode conductor or the separately derived system grounding electrode conductor shall be bonded at each end of the conduit to the grounding electrode conductor. If bonding jumpers are used they shall be sized per N.E.C. Table 250-66.

K. An earth electrode system shall be buried a minimum depth of two and a half feet. A # 2/0 bare copper ground wire, or if larger as sized on the drawings shall be run between ground rods.

L. All receptacles and switches shall be provided with ground jumper from outlet box to ground terminal of the device. Exception isolated ground receptacles.

M. Provide parallel equipment bonding jumper for parallel conduit feeders.

N. Provide bonding jumpers around all concentric or eccentric knockouts.

O. Include a bare # 2 copper ground conductor in all duct banks.

3.02 FIELD QUALITY CONTROL

A. Test the ground resistance to earth of each ground rod prior to connection to the system. Where test show resistance to ground is over 5 OHMS, report to DEN Project Manager locations and values. Submit test results to the DEN Project Manager.

B. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI / IEEE 81 Submit test results to the DEN Project Manager.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Bare Copper Ground will be measured by the number of linear feet of Bare Copper Grounding Conductor actually installed as determined by the RPR from field measurement.

B. Ground Rod will be measured by the number of each actually installed as determined by the RPR.

PART 5 - PAYMENT

5.01 PAYMENT

A. The Contract unit price for Bare Copper Ground and Ground Rod shall include full compensation for furnishing all labor, materials, equipment, tools and incidentals complete in place as shown on the Plans, and as specified in these Specifications.

Payment will be made under:

Item 26 05 26-1 Install #2/0 Bare Copper Grounding Conductor – per linear feet

Item 26 05 26-2 Install Ground Rod – per each

END OF SECTION 260526

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. RMC: Rigid metal conduit.

1.04 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.

1.05 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
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.

1.06 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.07 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".

1.08 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.09 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.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. one of the following:
a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. Fabco Plastics Wholesale Limited.
d. Seasafe, Inc.
e. Or approved equal.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

4. Rated Strength: Selected to suit applicable load criteria.

C. Hardware for hangers and supports shall be corrosion-resistant.

D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

E. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. 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.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. 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, stainless 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.

2.02 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

3.01 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. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. 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.

3.02 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 pounds (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. The use of pneumatic-actuated anchors is not allowed except at ceilings. Obtain DEN Project Manager approval prior to ordering materials or performing work.

H. Do not drill structural steel members.

I. Install surface-mounted cabinets and panelboards with minimum of four anchors

J. Suspended conduit or box supports shall not be less than 1/4 inch 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.

K. No more than five (5) 1/2 inch conduits, three (3) 3/4 inch" conduits or two (2) 1 inch conduits shall be supported on a single 1/4 inch diameter steel rod.

L. 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.

M. All light fixtures shall be independently supported at opposite corners from structure, or from trapeze supported from structure by the electrical contractor.

N. Wall-mounted fixtures shall be supported from building structure with backing support as approved by the DEN Project Manager to prevent any damage to the wall.

O. Use vibration isolation pads for vibrating equipment such as transformers.

P. Plastic or fiber anchors are prohibited.

Q. 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.

R. Route conduit through roof openings provided for piping and ductwork where possible; otherwise, route through roof jack with sealant approved by the roofing manufacturer.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

A. Install all freestanding electrical equipment on a 4 inch 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. Use 3,000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Item P-610 Concrete for Miscellaneous Structures.

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.

3.05 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.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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 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 associated equipment installation scope of work.

END OF SECTION 260529

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Innerduct
4. Metal wireways and auxiliary gutters.
5. Nonmetal wireways and auxiliary gutters.
6. Surface raceways.
7. Boxes, enclosures, and cabinets.
8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Division 26 Section 260526 "Grounding and Bonding for Electrical Systems" for additional grounding and bonding requirements.

C. Prohibited Materials

1. Intermediate conduits.
2. Aluminum conduit.
3. Multi-conductor assemblies, unless written authorization is obtained from DEN Project Manager, or specifically allowed within specification.

D. Project Conditions

1. Verify locations of outlets and small pull-boxes prior to rough in.
2. Electrical and pull boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

E. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.03 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. RMC: Rigid Metallic Conduit.

C. RNC: Rigid Nonmetallic Conduit.

D. EMT: Electrical Metallic Conduit.

E. FMC: Flexible Metallic Conduit.

F. LFMC: Liquidtight Flexible Metallic Conduit.

G. HDPE: High Density Polyethylene.

H. FNC: Flexible Nonmetallic Conduit.

I. ENT: Electrical non-metallic conduit.

J. MC: Metal-clad cable.

1.04 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1. Include data substantiating that materials comply with requirements.

B. LEED Submittals (if required):

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: Per request.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

D. Source quality-control reports.

1.06 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".

1.07 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

2.01 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.
13. Or approved equal.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

E. EMT: Galvanized tubing. Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel.

b. Type: Set screw or compression.

c. Provide throated connectors where entering junction boxes.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Innerduct:

1. Inner duct, meeting or exceeding the following requirements, shall be used to partition conduit.

a. Melting point: 260 degrees F., minimum.

b. Tensile yield strength: 3,600 psi/sq. in., minimum.

c. Brittleness temperature, maximum: -140 degrees F.

d. Heat distortion temperature: 170 degrees F minimum.

J. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corp.

6. Condux International, Inc.

7. Electri-Flex Company.

8. Kraloy.

9. Lamson & Sessions; Carlon Electrical Products.

10. Niedax-Kleinhuis USA, Inc.

11. RACO; a Hubbell company.

12. Thomas & Betts Corporation.

13. Or approved equal.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651B.

F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

G. RTRC: Comply with UL 1684A and NEMA TC 14.

H. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

J. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.
5. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
6. Or approved equal.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R or Type 4x, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type or screw cover.

E. Finish: Manufacturer's standard enamel finish.

2.04 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Moulded Products, Inc.
2. Hoffman; a Pentair company.
3. Lamson & Sessions; Carlon Electrical Products.
4. Niedax-Kleinhuis USA, Inc.
5. Or approved equal.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: Schedule 40 PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.05 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by the DEN Project Manager.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mono-Systems, Inc.
   b. Panduit Corp.
   c. Wiremold / Legrand.
   d. Or approved equal.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by DEN Project Manager from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Incorporated; Wiring Device-Kellems Division.
   b. Mono-Systems, Inc.
   c. Panduit Corp.
   d. Wiremold / Legrand.
   e. Or approved equal.

2.06 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.
18. Or approved equal.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Galvanized steel. Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover. Provide threaded hubs.

E. Nonmetallic Outlet and Device Boxes: Prohibited, unless specifically allowed in writing by the DEN Project Manager.

F. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Round Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Prohibited, unless specifically allowed by the DEN Project Manager.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 pounds. Outlet boxes designed for attachment of luminaires weighing more than 50 pounds shall be listed and marked for the maximum allowable weight.

I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 pounds.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Small Sheet Metal Pull and Junction Boxes: Galvanized steel. NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) or as approved by DEN Project Manager.

N. Gangable boxes are allowed.

O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R or Type 4x as appropriate, with continuous-hinge cover with flush latch unless otherwise indicated. Screw cover enclosures: VL50 & NEMA 1.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or Fiberglass.

3. Interior Panels: Steel; 14 gage steel, 12 gage if floor mounted, all sides finished with manufacturer's standard enamel, white.
4. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
   a. Interior Dry Locations: Use hinged or screw covered enclosure.
   b. Interior damp or wet locations: Use NEMA 3R hinged cover boxes.

P. Cabinets:

1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front finished inside and out with manufacturer's standard enamel, gray.
2. Cabinet Fronts: Steel, flush or surface type as indicated, with concealed trim clamps, concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.
3. Provide 3/4-inch thick fire retardant plywood backboard or galvanized steel back plate painted matte white, for mounting terminal blocks.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Fabrication:
   a. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.
   b. Provide knockouts on enclosures.
   c. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

Q. Terminal blocks and accessories:

1. All terminal Blocks: ANSI/NEMA ICS 4; UL listed.
2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw terminals, rated 600 volts.
3. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw terminals, rated 300 volts.
4. Power and signal/control wiring will use separate terminal blocks.

2.07 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Raceways shall not be installed in stairways or on the exterior of any building, unless specifically allowed by DEN Project Manager.

B. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: RMC.
2. Concealed Conduit, Aboveground: RMC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R Type 4.

C. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC . Raceway locations include the following:
   a. Loading dock.
   b. Baggage tunnels.
4. Exposed at exterior Apron Level.
5. Concealed in Ceilings and Interior Walls and Partitions: EMT.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Wet Locations: GRC.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

D. CONDUIT INSTALLATION SCHEDULE

1. Underground Installations More Than Five Feet From Foundation Wall: Polyvinyl Chloride (PVC) conduit Schedule 40. All bends greater than 45 degrees in non-metallic conduit shall be galvanized rigid steel conduit with a factory coating of polyvinyl chloride (PVC).
2. Installation In Concrete Slab: Not allowed.
   a. All buried conduits containing cabling shall be installed in concrete encased duct banks.
3. In Slab Above Grade: Not allowed.
4. Wet Interior Locations: Rigid steel.
5. Concealed Dry Interior Locations: Electrical metallic tubing.

6. In Existing Walls of Existing Structure: Electrical metallic tubing or MC Cable.

E. Minimum Raceway Size: 3/4-inch trade size.

F. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, or compression, steel fittings. Comply with NEMA FB 2.10.
   a. Setscrew fittings to be used for indoor applications in dry locations only.
   b. Compression fittings may be used in indoor or outdoor locations for damp or wet locations.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 degrees F.

I. Unless otherwise indicated and where not otherwise restricted, use the conduit type indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use Galvanized Rigid Conduit.

3.02 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Maintain a minimum of 6 inches (150 mm) between conduit and other piping. Maintain twelve inches (12 inches) clearance between conduit and a heat source such as heating pipes, exhaust flues and heating appliances. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 24 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines. Use conduit bodies to

make changes in direction around beams or columns.

H. Support conduit within 24 inches of enclosures to which attached. Support conduit at a maximum of 8 feet on center, within two (2) feet of a box or fitting.

I. Use only factory cast hubs for fastening conduit to cast boxes, and use steel or malleable iron hubs for fastening conduit to sheet metal boxes or equipment in damp or wet locations.

J. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

K. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture during construction.

L. Use PVC-coated rigid steel factory elbows for bends greater than 45 degrees in plastic conduit runs.

M. Exposed conduits subject to physical damage to be rigid steel to 6 feet above floor, deck or grating except in electrical, communications and mechanical rooms.

N. Conduit stubbed up shall be two inches above slab or housekeeping pad and the empty conduits shall be capped. Under freestanding equipment conduits with conductors shall be sealed with duct seal.

O. Flexible steel conduit runs shall not exceed 6 feet in length when connecting equipment, 6' in length when connecting light fixtures or when fished in hollow spaces with written approval by DEN Project Manager and shall contain a grounding conductor.

P. Stub-ups to Above Recessed Ceilings:

1. Use EMT or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

Q. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

R. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

S. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

T. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

U. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

V. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove

coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

W. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

X. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 160-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Y. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

Z. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

AA. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

BB. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

CC. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degrees F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 degrees F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 degrees F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
6. Provide external bonding jumper for all expansion fittings.

DD. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors. All vibrating equipment such as motors, transformers, and generators shall be connected with flexible steel conduit, not to exceed six feet in length.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

EE. Size conduit for conductor type installed or for Type THHN conductors, whichever is larger.

FF. Arrange conduit to maintain headroom and present a neat appearance. Certain existing conditions may allow a waiver to this item.

GG. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.

HH. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

II. Do not support conduit from cable tray or cable tray supports.

JJ. Flexible conduit shall not be less than one-half (1/2) inch except when supplied with lighting fixtures. MC Cable shall be allowed in lieu of flexible conduit for light fixtures in lengths of 6 feet or less.

KK. When anchoring to a dual sheet metal pan deck and concrete, anchors of any type when placed from below the deck shall be placed only in the lower pan form. No anchors shall be installed in the upper (high) pan.

LL. X-ray or ground penetrating radar studies shall be made of concrete floors, walls or CMU walls.

MM. Mount boxes at heights indicated on Drawings. Install boxes with height measured to center of box unless otherwise indicated. Coordinate mounting heights and locations of boxes or outlets so as not to be interfered with by grounding systems, electrical panels, or any other building accessory.

NN. Coordinate installation of outlet or equipment boxes for systems or products furnished under other sections.

OO. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

PP. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Provide minimum 8 inch separation.

QQ. Locate boxes so that cover or plate will not span different building finishes.

RR. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

SS. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

TT. Set metal floor boxes level and flush with finished floor surface.

UU. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

VV. Install electrical boxes as shown on Drawings, and as required for equipment, terminal strips, splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

WW. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed light fixture.

XX. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

YY. Use adjustable steel channel fasteners or all thread for hanging ceiling outlet box, support box from structure.

ZZ. Support boxes in the ceiling with 1/4 inch threaded rod as a minimum.

AAA. Use appropriate gang box where more than one device is mounted together.

BBB. Use 4 inch square box with plaster ring for single device outlets.

CCC. Use malleable iron outlet box when surface mounted: on exterior of building, in wet location or damp location.

DDD. Minimum junction and pull box size 4-11/16" x 4-11/16" x 2-1/8".

EEE. Minimum outlet box size 4" x 4" x 2-1/8” including feed through outlet boxes.

FFF. Minimum junction box size for fire alarm pull stations, control module, monitor module, 4" x 4" x 2-1/8". Provide plaster ring at all pull station locations.

GGG. Use flush mounting outlet boxes in finished areas.

HHH. Install knockout closure in unused box openings.

III. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

JJJ. All floor-mounted equipment shall be on a 4-inch nominal concrete housekeeping pad.

KKK. No cabinet shall be supported on slab or grade.

3.03 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.04 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.05 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

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 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 associated equipment installation scope of work.

END OF SECTION 260533

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

B. Related Sections:

1. Item P-153 "Controlled Low-Strength Material (CLSM)" for flowable backfill.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.03 DEFINITIONS

A. RNC: Rigid nonmetallic conduit.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes.
4. Warning tape.
5. Warning planks.
6. Include data substantiating that materials comply with requirements.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.

4. Ladder details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.05 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

C. Qualification Data: For professional engineer and testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

1.06 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".

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.09 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical 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 electrical service without Owner's written permission.

1.10 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by DEN Project Manager.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 10 percent of quantity of each item installed.

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

2.01 CONDUIT

A. Rigid Steel Conduit: Galvanized Rigid Conduit (GRC) with factory bonded 40 mil. PVC coating. Comply with ANSI C80.1.

B. Rigid metallic conduit used for elbows and sweeps shall be PVC coated, schedule 40 galvanized rigid conduit bent to shape at the factory. All connections to Non-Metallic rigid conduits shall be made with threaded couplings.

C. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.
12. Or approved equal.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Inner-ducts shall be nominal 1-inch internal diameter with longitudinally fluted (finned) construction to reduce cable pulling friction. Inner-ducts shall be manufactured of high density polyethylene and provided in blue, orange and black. Inner-duct shall be installed in unbroken (no couplings) lengths between Underground Concrete Vaults and pull boxes.
3. Pull Tape shall be 3/4 inch wide woven Aramid fiber with no more than 4 percent elongation at yield. Tape shall provide a tensile strength of 2500 lbs. Tape shall be provided with accurate sequential footage marks at one foot intervals.
4. Flow able backfill shall be 60 to 100 psi, Designed in accordance with ASTM C 94 and ASTM D 4832. Reference Item P-153 "Controlled Low-Strength Material (CLSM)".
5. Red concrete for encasement shall be 3,000 psi minimum, 28-day compressive strength and 3/8-inch maximum aggregate size. The color shall be Davis Color “Baja Red.” Use Davis Color # 160 at a ratio of two (2) pounds powder dose for each sack of cement in the mix or equal as determined by the manufacturer and DEN Project Manager to achieve desired color.
6. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

7. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6,000-psi concrete.
   a. Color: a specified for encasement concrete above.
   b. Mark each plank with "ELECTRIC" in 2-inch high, 3/8-inch deep letters.
8. Mortar shall comply with ASTM C 270, Type M, except for quantities less than 2.0 cubic feet where packaged mix complying with ASTM C 387, Type M, may be used.
9. Steel bore casings shall be ASTM A/252 Grade 2
10. Counterpoise conductor shall be #6 bare hard drawn or soft drawn copper. Exothermic welds shall be utilized at all connections.

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

A. Design guidelines for Precast Pull Boxes: Precast pull boxes shall be provided as round units with 4 feet nominal interior diameter. Boxes shall be of two-piece construction with side walls and base cast as one unit and precast lid as a separate piece. Waffle-board knockout panels shall be provided at a minimum of four (4) equally spaced positions around the perimeter of the pull box to facilitate conduit entry. Pullboxes shall be provided with the following accessories:
   1. Bolt-on UCV step, stainless steel
   2. Embedded eyebolts, stainless steel
   3. Collar ring, cast steel, 30-inch inside diameter
   4. Cover, cast steel, 30-inch diameter (Marked DEN Communications)
   5. Provide plugs on all conduit entering pull boxes. Plugs shall provide a tight seal between conduit and pull tapes and shall withstand a minimum of 15 psi of hydrostatic pressure.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carder Concrete Products.
   2. Christy Concrete Products.
   3. Elmhurst-Chicago Stone Co.
   4. Oldcastle Precast Group.
   5. Riverton Concrete Products; a division of Cretex Companies, Inc.
   6. Utility Concrete Products, LLC.
   7. Utility Vault Co.
   8. Wausau Tile, Inc.
   9. Or approved equal.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Manhole and hand hole covers and hinges shall be cast iron or stainless steel unless indicated otherwise.
2. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
4. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE." As indicated for each service.
5. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches .
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
9. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE." As indicated for each service.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.05 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc.
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.
19. or approved equal.

2.06 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

A. Underground conduits shall be Poly-vinyl Chloride (PVC) schedule 40 or greater, or Galvanized Rigid Conduit (GRC) with factory bonded 40 mil. PVC coating.

B. All underground duct banks inside and outside of the building shall be encased in red concrete, supported on listed conduit spacers every five (5) feet, with a minimum of three (3) inches of cover on all sides and two (2) inches between conduits at a minimum depth of 36 - inches from top of concrete encasement to finished grade. A 3” wide red metallized foil core detectable warning tape shall be placed over the duct bank at a depth not exceeding the manufacturer’s recommendations.

C. Concrete encased duct banks shall be utilized for all primary duct banks at DEN. Primary duct banks are considered those duct banks that form the main arteries of the DEN duct bank system and those serving any DEN owned facility or structure. Concrete encasement shall also be used on segments of direct buried duct bank that cross under paved roadways or other locations subject to vehicular traffic.

D. Include a bare #2 copper ground conductor above conduits in all concrete encased duct banks.

E. A 1-inch minimum size shall be used for underground conduit.

F. The minimum size of any underground high voltage (above 1,000 volt) conduit shall be 4 inches.

G. A separate insulated ground wire shall be installed in each conduit. The ground wire shall be sized on the drawings or in accordance with NEC article 250.

H. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 -PVC, in concrete-encased duct bank, unless otherwise indicated.

I. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

J. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.02 UNDERGROUND ENCLOSURE APPLICATION

A. Mid-sized UCV's (12'-0" L x 6'-0" W x 7'-0" H interior dimension) shall be utilized for all main duct banks at DEN. Main duct banks shall be considered those duct banks serving more than one facility or containing more than four (4) 4-inch conduits. Mid-sized UCV's may contain fiber-optic cabling, copper cabling or both. Many of the mid-sized UCV's will contain splice cases, repeaters and other outside plant devices.

B. Small UCV's (6'-0" L x 4'-0" W x 7'-0" H interior dimension) may be utilized for branch connections which serve only a single facility and contain four (4) or fewer ducts. These UCV's may contain fiber-optic cabling, copper cabling or a combination of both. These UCV's are not suitable for housing splice cases, repeaters, etc. Small UCV's should be reserved for straight through pulls of copper or fiber cabling.

C. The standard DEN pull box is a round unit approximately 48-inches in internal diameter and approximately 48-inches deep. This pull box is to be used on duct bank runs containing no more than two conduits and supporting fiber-optic cable only. These boxes do not provide sufficient space for copper splice cases.

D. UCV's shall be placed within 100-feet of any 90-degree turn in the duct bank and at intervals of approximately 500-feet. Pull boxes on fiber-optic only duct banks may be placed at intervals of approximately 750-feet. Adjust spacing to avoid paved areas and traveled roadways.

E. The standard DEN UCV contains break out ports for 4-inch schedule 40 PVC on two opposing ends. UCV's should not be placed directly at the corner point for a 90-degree duct bank turn. Do not modify UCV's with sidewall openings where no conduit ports exist as to do so complicates cable racking and splice case placement on larger cable sizes.

F. The standard DEN pull box contains break-out waffle panels at intervals around the pull box circumference. Arrange ducts to enter and exit the pull box on directly opposite break-out panels to allow for straight-through cable pulls.

G. When arranging ducts in UCV's and pull boxes, utilize the lower ports first, starting with the bottom most port and working upward. Ensure that the pattern of ducts (ie:1, 2, 3, 4 etc.) remains the same on both ends of a duct run. For example, on a north-south duct run the lowest duct on the east side leaving one UCV would also be the lowest duct on the east side at the next UCV.

H. Handholes and Boxes for 600 V and Less: Units located in subjected to aircraft loads shall comply with aircraft rating standards per FAA AC 150/5320-6 (current edition).

3.03 EARTHWORK

A. Excavation and Backfill: Comply with Item P-152 "Excavation, Subgrade, and Embankment," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. After installation of electrical work, backfill with flowable backfill to insure against the possibility of differential settling, then use flowable backfill to within 8 inches of final grade.

C. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.04 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches , vertically, and 9 feet horizontally, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid PVC coated steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

F. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

H. Pulling Cord: install pulling cord in ducts, including spares.

I. When concrete encased duct bank or conduit penetrates a foundation wall of a manhole, hand hole, or large pull box, the encasement is required to be structurally attached to the wall. Furnish for approval a shop drawing showing the conduit terminations and how the concrete encasement will be tied into the structure.

J. No conduits shall be encased in sidewalks, roadways, footings, grade beams and foundations except under special cases approved by the DEN Project Manager.

K. Conduit penetrating a foundation wall or wall of a handhole or manhole shall be sleeved and continuous (without fittings) from the interior for a minimum of five (5’) on the exterior. Conduit penetrating a footer or grade beam shall be sleeved and continuous for five feet (5’) on either side of a footer or grade beam using a single ten foot piece of PVC coated GRC. Conduit penetrating a wall, footer or grade beam below grade shall be plastic coated rigid steel conduit. Conduit penetration of an exterior wall or wall of a handhole or manhole shall be made watertight.

L. All GRC entering or leaving manholes, hand holes or switch gear shall have a grounding bushing attached to the conduit and the ground wire attached to the bushing.

M. Bell fittings shall be installed on all PVC conduits entering or leaving manholes or hand holes.

N. All conduits in manholes and hand holes that contain conductors shall be sealed by duct seal and all empty conduits shall be sealed with an approved fitting.

O. All cable shall be racked and supported in manholes.

P. Manholes and hand holes shall be water tight; joints in precast hand holes and manholes shall be filled with non-shrink mortar and finished flush with the adjoining surfaces after being made watertight.

Q. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.

9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches . Space additional tapes 12 inches apart, horizontally.

R. Special Duct Bank Construction at Corners

1. The duct bank system at DEN supports copper cabling in sizes up to 1800 pairs. The pulling tension required to install these cable requires the use of winches and steel cables. Special provisions are required at corners to prevent these cables from sawing through the sidewall of the ducts.
2. Corners in the duct bank system are required to be made with 4-inch galvanized rigid PVC coated conduit with a radius of at least nine (9) feet. Concrete encasement is required at corners to control stresses and movement in the duct system during cable installation.

S. Duct Bank Provisions for Fiber Optic Cabling

1. Ducts designated for fiber-optic cabling shall be provided with three 1-inch inner-ducts. The three inner-ducts installed in each fiber duct shall be colored blue, orange and black.

3.05 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 24 inches below finished grade.

2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

4. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Frame and Cover: Install grade rings centered on UCV top opening to elevate frame and cover to correct elevation. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to grade rings. Provide additional steps in UCV throat at any location where the height of the grade rings exceeds 18-inches.

G. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

H. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

I. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

J. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

K. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

L. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.07 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.09 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Remove and Replace Handhole will be measured by the number of each handhole actually removed and replaced.

PART 5 - PAYMENT

5.01 PAYMENT

A. The Contract unit price for handhole and junction box shall include full compensation for furnishing all labor, materials, equipment, tools, and incidentals including excavation, hauling and disposal and for performing all the work of installing handhole complete in place as shown on the Plans, and as specified in these Specifications.

Payment will be made under:

Item 26 05 43-1 Remove and Replace Fueling System Handhole – per each

END OF SECTION 260543

SECTION 260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data substantiating that materials comply with requirements.

1.04 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

2.01 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.

b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.

b. CALPICO, Inc.

c. Metraflex Company (The).

d. Pipeline Seal and Insulator, Inc.

e. Proco Products, Inc.

f. Link-Seal.

g. Or approved equal.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel or Stainless steel.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Presealed Systems.

b. Or approved equal.

2.04 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
   a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

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 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 associated equipment installation scope of work.

END OF SECTION 260544

SECTION 260583

ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 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. From electrical source to motor starters.
2. From motor starters to motors.
3. To lighting fixtures and wiring devices.
4. To converters, rectifiers, transformers, inverters, switchgear, switchboards, panel boards, generators and similar equipment.
5. To grounds including ground electrode connections.
6. Equipment furnished in other Divisions (unless indicated otherwise).
7. Electrical connections for equipment, that are not furnished as integral part of equipment, are specified in Division 22, Division 23, and other Division 26 sections, and are criteria of this Section.
8. Refer to Division 22 and Division 23 sections for motor starters and controllers furnished integrally with equipment; not criteria of this Section.
9. Refer to Division 22 and Division 23 sections for control system wiring, not criteria of this section.
10. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 26 sections, and are criteria of this Section.

C. Related requirements:

1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables".

D. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.03 ACTION SUBMITTALS

A. The following data shall be submitted in accordance with Sections 013300 "Submittal Procedures" required prior to starting installation:

1. Product Data: Manufacturer’s data on electrical connections for equipment products and materials.

a. Include data substantiating that materials comply with requirements.

2. Complete wiring diagrams and/or shop drawings for installation purposes shall be furnished under the Mechanical or other Divisions, as required by DEN Project Manager, prior to installation.

1.04 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".

1.05 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 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.

1.06 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

2.01 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.

2.02 MECHANICAL AND ELECTRICAL COORDINATION

A. Responsibility: It is the contractor’s responsibility to complete the EXHIBIT A SCHEDULE included at the end of this Section. Reference Section 019990 "Standard Forms". The Contractor shall include all costs and work associated with these items in his bid.

B. Verify location, size, and characteristics of all mechanical equipment before installation of electric service. In all cases of the installation of heating, ventilating, air conditioning, plumbing, and other mechanical equipment, the Contractor is responsible for all revisions, changes, and modifications necessary to properly supply electric services to the equipment.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 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.

3.03 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.

3.04 EQUIPMENT CONNECTION SCHEDULE

A. Furnish, set in place, and wire, except as may be otherwise indicated, all heating, ventilating, air conditioning, plumbing, fire protection, and other motors and controls in accordance with the electrical/mechanical coordination schedule. The contractor shall carefully coordinate with work performed under the Mechanical and other Divisions if these specifications.

B. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Division 26 of the technical specifications.

C. Provide NEMA-rated motors and equipment suitable for operation on the voltage systems as designated below, with tolerances for the allowable voltage variations above and below the nominal:

1. Rated Motor Voltage:

Service Voltage and Phase:	1/3 HP and smaller 1-Phase:	1/2 HP and Larger 3-Phase:
120/208V, 3-Phase	115V	208V (only when 480V is not available)
277/480V, 3-Phase		460V

3.05 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. All medium voltage splices and terminations are to be made by a certified cable splicer/terminator.
3. 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.
4. Splices shall be covered with electrical insulating material equivalent to, or of greater insulation rating, than electrical insulation rating of those conductors being spliced.
5. Cables and wires shall be trimmed as long as practicable and routing shall be arranged to facilitate inspection, testing, and maintenance.
6. Connectors and terminals, including screws and bolts, shall be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings shall be used to comply with torquing values contained in UL 496A or the manufacturer's literature.

7. 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.

3.06 FIELD QUALITY CONTROL

A. The correct direction of rotation of each motor is to be verified.

B. Provide measured torquing value checklist with witness signature to DEN Project Manager.

C. Perform infrared scanning of all splices and terminations as required in Section 260519 "Low-Voltage Electric Power Conductors and Cables".

PART 4 - MEASUREMENT

4.01 MEASUREMENT

A. No separate measurement will be made for the work specified in this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work specified in this Section. The cost of the work described in this Section shall be included in the associated equipment installation scope of work.

END OF SECTION 260583

SECTION 262726

WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPD: Surge Protective Device.

F. UTP: Unshielded twisted pair.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.08 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. Floor Service-Outlet Assemblies: One for every 10 but no fewer than one
2. floor service outlets installed, but no fewer than two.
3. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

1.09 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

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).
5. Or approved equal.

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, 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 NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.03 STRAIGHT-BLADE RECEPTACLES

A. Unless noted otherwise, all general-use straight blade devices shall be gray.

B. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5351 (single), CR5362 (duplex).
   b. Hubbell; HBL5351 (single), HBL5352 (duplex).
   c. Leviton; 5891 (single), 5352 (duplex).
   d. Pass & Seymour; 5361 (single), 5362 (duplex).
   e. Or approved equal.

C. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; IG5362RN.
   b. Hubbell; IG5362.
   c. Leviton; 5362-IG.
   d. Pass & Seymour; IG5362.
   e. Or approved equal.
2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

D. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; TR8300.
   b. Hubbell; HBL8300SGA.
   c. Leviton; 8300-SGG.
   d. Pass & Seymour; TR63H.
   e. Or approved equal.

2.04 GFCI RECEPTACLES

A. Unless noted otherwise, all GFI receptacles shall be gray.

B. General Description:

1. Straight blade, feed through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

C. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; VGF20.
   b. Hubbell; GFR5352L.
   c. Pass & Seymour; 2095.
   d. Leviton; 7599.
   e. Or approved equal.

D. Duplex SPD Convenience Receptacles:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5362BLS.
   b. Hubbell; HBL5362SA.
   c. Leviton; 5380.
   d. Pass & Seymour; 5362BLSP.
   e. Or approved equal.
2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

2.05 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Crouse-Hinds.
   b. EGS/Appleton Electric.
   c. Killark; Division of Hubbell Inc.
   d. Or approved equal.

2.06 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Unless noted otherwise, toggle switches shall be gray.

C. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Single Pole:
      1) Cooper; AH1221.
      2) Hubbell; HBL1221.
      3) Leviton; 1221-2.
      4) Pass & Seymour; CSB20AC1.
      5) Or approved equal.
   b. Two Pole:
      1) Cooper; AH1222.
      2) Hubbell; HBL1222.
      3) Leviton; 1222-2.

4) Pass & Seymour; CSB20AC2.
5) Or approved equal.

c. Three Way:
1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; CSB20AC3.
5) Or approved equal.

d. Four Way:
1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; CSB20AC4.
5) Or approved equal.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.
e. Or approved equal.

2.07 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Type 302/304 stainless steel 0.04 inch (1mm) thick.
3. Material for Unfinished Spaces: Type 302/304 stainless steel 0.04 inch (1mm) thick.
4. Material for Damp Locations: Type 302/304 stainless steel 0.04 inch (1mm) thick.
5. Plastic covers will not be accepted.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, Type 302/304 satin stainless steel with lockable cover.

2.08 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Gray.
2. Wiring Devices Connected to Emergency Power System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Finish: 302/304 satin stainless steel. Plastic covers will not be accepted.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Mounting heights shall be as shown on drawings. If no heights noted, standard device heights above finished floor are as follows:
    a. Wall switches: 48 inches.
    b. Convenience receptacles: 18 inches.

E. Receptacle Orientation: Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles install ground pin to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
2. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

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 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 associated equipment installation scope of work.

END OF SECTION 262726

SECTION 283801

EMERGENCY FUEL SHUTOFF SYSTEM

PART 1 - GENERAL

A. REFERENCES

A. Applicable Codes and Standards:

1. Contractor shall furnish Equipment which conforms in all respects to applicable industry standards and sound engineering practice.
2. Design, fabricate, assemble, install, and test Equipment to conform to the applicable provisions of the following standards:
   a. Institute of Electrical and Electronics Engineers (IEEE):
      a. 472 - Surge Withstand Capability Test.
      b. 518 - IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources.
   b. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
      b. 407 - Aircraft Fuel Servicing.
   c. National Electrical Manufacturers Association (NEMA):
      a. ICS - Industrial Controls and Systems.
   d. Underwriters Laboratories (UL):
      a. 508 - Industrial Control Equipment.
      b. All components shall be UL listed.
   e. Scientific Apparatus Manufacturer's Association (SAMA).
   f. Instrument Society of America (ISA).
   g. National Electrical Safety Code (NESC).

B. Related specifications

1. Section 260400 – Basic Electrical Requirements
2. Section 260510 – Testing, Acceptances and Certification
3. Section 260519 – Low-Voltage Electrical Power Conductors
4. Section 260523 – Control-Voltage Electrical Power Cables
5. Section 260533 – Raceways and Boxes for Electrical Systems
6. Section 260553 – Identification for Electrical Systems

B. ABBREVIATIONS

A. CADD – Computer-Aided Design and Drafting

B. EFSO – Emergency Fuel Shutoff

C. NFPA – National Fire Protection Association

D. NICET – Nation Institute for Certification in Engineering Technologies

E. COTR – Contracting Officer’s Technical Representative

F. PLC – Programmable Logic Controller

C. GENERAL DESIGN REQUIREMENTS

A. Separate EFSO System drawings shall be provided for the additions to the existing EFSO System. Design drawings shall include, as a minimum, a comprehensive system riser diagram; layout plans; input/output operating/mapping matrix, and all equipment/device locations. All drawing symbols shall be in accordance with NFPA 170, Fire Protection Symbols for Architectural and Engineering Drawings. EFSO System shop drawings and calculations shall be prepared by a designer possessing as a minimum NICET (National Institute for Certification in Engineering Technologies) Level III certification in system design.

B. All EFSO system Contractor provided shop drawings and calculations shall be sealed and signed by a licensed Professional Engineer registered in the State of Colorado. Shop and Project Record (As built) drawings shall be produced using CADD systems. The requirements for CADD production of documents are described in CADD Volume. The drawings shall also show the system as installed, including all deviations from the approved shop drawings.

D. EFSO SYSTEM CONFIGURATION

A. EFSO system configuration as a minimum shall consist of the following components:

1. EFSO signage.
2. EFSO locator lights.
3. EFSO strobe lights.
4. EFSO manual pull boxes.
5. TRI modules, wiring, terminations, mounting hardware and mast, enclosures, back boxes, and other ancillary items as required.

E. CIRCUIT PROTECTION

A. All initiating and alarming circuits shall be protected against power surges per manufacturer’s recommendations.

F. SYSTEM TESTING, COMMISSIONING, AND TURNOVER

A. System Pre-Testing: EFSO system additions shall be pre-tested upon completion of the installation. The Contractor shall be required to align, adjust, and balance the system and perform complete pre-testing sequence to conform to the requirements of the contract drawings and specifications. Upon completion of the pre-testing the Contractor shall be required to provide a letter to the COTR certifying that the installation is complete and fully operable with copy of the completed pre-testing documentation attached. The Contractor shall be required to provide a minimum of five calendar days' notice in writing to the COTR when the system is ready for final and formal acceptance testing. The Contractor shall be required to schedule final and formal acceptance test only after all required written certifications and test reports have been submitted and approved.

G. FINAL AND FORMAL TESTING ACCEPTANCE PROTOCOL

A. EFSO system shall be ready for use, completely operational and formally accepted at a minimum of 15 calendar days before fuel system usage is planned. The Contractor shall be required to have the presence of the manufacturer’s authorized technical representative at all acceptance tests and re-tests. The formal system acceptance shall be in accordance

with the procedures in the NFPA, and the Authority testing protocol including a complete 100 percent operational test. Visual inspection of workmanship, number, and placement of devices, and wiring methods, EFSO control panel operational testing, including power, supervision and device testing. All approved project submittals, drawings, sequence of operations document, specifications, certifications, test reports (results) and final Project Record Drawings shall be available at test locations.

H. WRITTEN CERTIFICATIONS AND/OR TEST REPORTS

A. General Requirements: Six copies of certifications and/or test reports (results) shall be submitted by the contractor before final and formal acceptance testing is scheduled for the following:

1. MANUFACTURER'S LATEST RECOMMENDATIONS: Written certifications and test reports (results) shall confirm full compliance with the manufacturer's latest recommendations and NFPA wiring including:
   a. Maximum line resistance.
   b. Maximum line capacitance.
2. OPERATING INSTRUCTIONS FOR THE TEST MODEL: Written certification and test reports (results) confirming full compliance with all tests listed in the manufacturer's recommendations for "Operating Instructions for the Test Model."
3. GROUND FAULTS: Written certification and test reports (results) confirming the system is free of ground faults, short circuits, and the absence of unwanted voltages between circuit conductors and ground as per manufacturer recommendations and NFPA 72.
4. SYSTEM CHECKOUT PROCEDURE: Written certification and test reports (results) of complete system checkout procedure as per manufacturer installation recommendations and NFPA 72.
5. FINAL SYSTEM PROGRAMMING: Written report on final system programming and configuration.

I. DELIVERABLES DUE AT FINAL AND FORMAL ACCEPTANCE TESTING

A. One (1) copy of the following shall be provided.

1. Project Record Documents: Project Record Documents as required by Division 01 specifications.
2. Wiring Index: Wiring and circuit coding index.
3. Project Record Wiring Diagrams: Project record schematic wiring diagrams of all EFSO panels, other control panels and annunciators, and any other ancillary equipment.
4. Operation and Maintenance Manuals: Operation and Maintenance Manuals as required by Division 01 specifications.
5. Spare Parts: All spare parts, components, and equipment.

J. SUBMITTALS

A. Refer to general provisions of the contract, electrical technical specifications, "Section 013300 – Submittal Procedures", and Division 01 for administrative and procedural requirements for submittals.

B. Specific Submittals to be furnished for Equipment shall include at least the following:

1. Device list and bills of material.
2. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions for all equipment provided, including but limited to the following:
   a. EFSO Stations
3. Experience record of system integrator's field personnel assigned to the project.
4. System architecture drawing (Control System Block Diagram) showing all input/output cabinets, communications interfaces controller cabinets, operator interface devices, data storage devices, prefabricated cables and interfaces to other systems, and related components. This drawing shall represent the physical composition of the system.
5. Complete system wiring diagrams, including internal and external connections to EFSO Control Panel.
6. Program documentation for all software operating systems, editors, compilers, utilities, application, control, and logic programs, both for the control, data acquisition, and processing functions.
7. Color copies of proposed HMI screens.
8. Operation and Maintenance Manual including, but not limited to, the following (provide nine (9) printed copies and nine (9) flash drive copies):
   a. All information listed above, in its final configuration.
   b. List of recommended spare parts.
   c. Instruction manuals.
   d. Description of operation of control Equipment.
   e. Description of power failure and restoration mode.
   f. Warranty documentation as indicated in PART 3.
   g. Copies of all software necessary to restore system.

K. TRAINING

A. Provide systems training in accordance with Section 017515 - System Startup, Testing, and Training.

B. Provide qualified factory trained personnel to provide a training session at DEN's facility to train DEN personnel in the configuration, operation, and maintenance of all hardware/software provided. The training session shall be of sufficient content and duration to provide a basic understanding of the hardware/software in general and specific instruction on the Site-specific implementation. This training shall be a minimum of two (2) days in duration. The training session shall be coordinated with DEN and Contractor.

L. SYSTEM INTEGRATOR

A. Qualifications:

1. Normally involved in the design and manufacture of specially constructed control panels. Experience in the programming, design, manufacture, and installation of control panels and systems for a minimum of five years, normally involved in EFSO work.
2. Capability of assembling all components and completing all internal wiring.

3. Capability to complete design of the total control panel and provide shop drawings to DEN prior to accomplishing assembly.
4. Capability to simulate each function required and complete all testing specified.
5. Capability of supporting the start-up and checkout of the total system and provide field service as required at the installation site.
6. UL-listed panel shop

B. Acceptable Vendors

1. Custom Control Manufacturer

   5601 Merriam Drive

   Merriam, KS 66203

   Tel: (913) 722-0343

   Web: www.customcontrolmfr.com

   Attn: Lewis Sanders

2. Telemetry and Process Controls

   7250 Hudson Boulevard, Ste. 160

   Oakdale, MN 55128

   Tel: (651) 430-0435

   Web: www.tpcusa.com

   Attn: Dan Edison

PART 2 - PRODUCTS

A. GENERAL

A. Install all EFSO System equipment as covered by the drawings and this specification, to be wired, connected, and left in operating condition.

B. The EFSO System shall have sufficient capacity to incorporate all equipment and perform all functions as indicated, including communications, indication, monitoring, and control.

C. The EFSO System shall have a maximum latency of two (2) seconds, between a manual or automatic activation and the associated indication or operation; regardless of the location of either.

D. All components used in the EFSO System shall be UL-listed.

B. EFSO CONTROL PANELS

A. Each new EFSO Control Panel shall be fabricated in accordance with the drawings and this specification. The panels shall be wall mounted as indicated on the drawings. The panels in each EFSO room shall meet the following requirements:

1. NEMA 4X, stainless steel, pad lockable latch, steel pocket on the inside of the door for storage of panel drawings, back plate for equipment mounting

   A. Hoffman enclosure or approved equal.

2. EFSO System field wiring shall meet requirements of Section 260519.

3. EFSO Control Panel internal wiring shall be as follows:

   a. Provide all wiring necessary for equipment specified for installation, including internal wiring for all spare equipment and all future connections as indicated.

   b. NEC type THHN/MTW wire, rated at 600V.

   c. Wire shall be sized for load being served.

   d. Wiring shall be color coded consistently within panel.

4. Provide lightning protection surge arrestors on all field inputs to the EFSO Control Panel in PLC enclosure. Provide 100% spare space in enclosure.

   a. Phoenix Contact TT-2-PE-24DC, 2838186 surge protective device or approved equal.

5. All equipment and wiring shall be arranged to allow complete accessibility to all terminals.

6. The EFSO Control Panel shall include a dedicated 24-volt, direct-current, (24 VDC) power supply and uninterruptible power supply (UPS) with battery in a separate enclosure sized to power all connected devices for a minimum of 20 minutes. Power supply shall have 120-volt, alternating-current, (120 VAC) input. The UPS shall function such that upon a loss of utility power, the load will remain on-line and have no interruption of power. The UPS shall have alarm contacts for low battery, battery-on, and battery fault. These alarms shall be inputs into the PLC.

   a. Sola SDU 10-24 DC UPS power module, 240VA.

   b. Sola SDU 24-BATEM external battery mount module, 24V.

7. Provide circuit breakers to separately power the following devices from the 24 VDC UPS:

   a. PLC and associated I/O modules.

   b. Control valves in valve vault.

   c. All other equipment in the panel.

8. All terminal blocks shall have terminal marking strips with each terminal marked. Provide 25% spare terminals on all terminal blocks. Terminal blocks shall be provided for all field wiring, labeled accordingly.

   a. Allen-Bradley, Phoenix Contact UK5N, or approved equal.

9. Each input shall be separately fused with LED blown fuse indicator. Input signals to the system or output signals from the system shall be isolated and either current limited or fused from the internal circuitry so that shorting, grounding or opening the circuit at the receiving or transmitting equipment will not affect control system performance.

B. Provide programmable logic controller (PLC) with all appurtenances and accessories required for a complete system. PLC shall accept inputs and provide outputs as indicated in this specification and on the construction drawings. Provide additional input, output, and data cards as required. PLC shall contain integral screen to monitor data, modify data, and interact with the control program. The LCD shall also display status for embedded digital I/O and controller functions.

1. Allen-Bradley – Micrologix 1100.

C. Indicating lights shall be 24VDC, LED.

1. Allen Bradley series 800T-QSH24 series, or approved equal.

D. Managed Industrial Ethernet Switch

1. Red Lion N-Tron 710FX2-SC-15, or approved equal.

E. Foundation Field Bus Equipment

1. IO Module – Dupline GS75102101, or approved equal.

2. DuplineSafe – Profibus-DP Gateway, or approved equal.

C. EFSO STATIONS

A. All EFSO station modifications shall consist of new items.

B. All components shall be UL Listed for outdoor use.

C. All new or replacement pushbuttons shall be as follows.

1. Pushbutton and enclosure shall be PILLA Part #FS120-KR-MT4.

2. Pushbutton shall be supplied with plastic cover, Part # PILCLHCOV1, to prevent accidental activation.

3. Pushbutton reset shall be keyed to match existing pushbuttons.

D. TEST EQUIPMENT

A. Any special test kits, programmers, cables, software, or other test accessories that are unique to the manufacturers' Equipment, used in operation or maintenance of this Equipment shall be provided.

PART 3 - EXECUTION

A. GENERAL

A. At no time during the installation or modifications of the EFSO system as covered by the drawings and this specification, shall any part of the EFSO system for operational gates be interrupted.

B. INSPECTION

A. Inspect area and conditions under which system equipment is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. INSTALLATION

A. Install the system in accordance with the plans and specifications, all national and local applicable codes, and the manufacturer's requirements and recommendations.

B. The system integrator shall provide all on-site software modifications, equipment adjustments, and supervision of the complete EFSO Control System installation.

D. TERMINAL EFSO SYSTEM OPERATION

A. The EFSO Control Panel shall monitor the following devices in each respective Terminal:

1. EFSO Stations.

B. The following "trouble" events shall be displayed on each PLC screen, transmitted to the DEN control system and annunciated on the control room HMI:

1. Loss of communication with any EFSO station.
2. Loss of communication with any EFSO PLC.
3. Uninterruptible power supply "Low Battery".
4. Uninterruptible power supply "On Battery".
5. Uninterruptible power supply "Battery Fault".

C. The following "critical" events shall be displayed on each PLC screen, transmitted to the DEN control system and annunciated on the control room HMI: Coordinate with fuel system operator on when to also sound existing alarm horn controller by PLC at fuel storage facility.

1. Activation of EFSO pushbutton station.

D. The following emergency fuel shutoff sequence of operation shall initiate upon activation of an EFSO pushbutton station, or remote software button on DEN control room HMI:

1. Upon activation of an EFSO pushbutton, the EFSO locator light (constantly illuminated in non-alarm state) shall flash. Unit shall continue flashing until the EFSO station pushbutton is reset locally.
2. Refer to "Emergency Response Plan" for further information regarding sequence of operation after EFSO pushbutton activation.

E. New EFSO system reset shall be accomplished by the following procedure:

1. Determine and correct the problem at the activated EFSO station.
2. If an EFSO station was activated, reset the EFSO station push button.
3. Reset the new EFSO Control Panel by means of the keyed reset switch located on face of control panel enclosure.
4. Upon reset of the new EFSO Control Panel energize the solenoids on the flow control valves and return the hydrant system to normal operation.

E. START-UP AND TESTING

A. The EFSO system shall be fully functionally tested by the system integrator in the presence of the Owner's Representative, the fuel system operator (DEN), the contractor, and local authorities having jurisdiction. Upon completion of a successful test, the system integrator shall so certify in writing to the Owner and Contractor.

B. Start-up and testing will be required for each phase of construction. Coordinate with Program Manager for phasing requirements.

F. WARRANTY

A. The Contractor shall warrant the completed EFSO system wiring and equipment to be free from inherent mechanical and electrical defects for a period of two (2) years from the date of substantial completion and acceptance by DEN.

PART 4 - MEASUREMENT

A. METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

A. METHOD OF PAYMENT

A. Payment for installation and modifications of the EFSO pushbutton stations comply with this specification will be made at the contract unit price per lump sum for work installed in-place, completed, and approved by the DEN. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 283801-1, EFSO Modifications (Gate A42) – per lump sum

Item 283801-2, EFSO Modifications (Gate A44) – per lump sum

Item 283801-3, EFSO Modifications (Gate A46) – per lump sum

END OF SECTION 283801

SECTION 312001

SITE PREPARATION AND EARTHWORK FOR FUEL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes the following.

1. Excavating and backfilling for underground fuel piping.
2. Pipe bedding.

1.02 REFERENCES

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. C33 - Standard Specification for Concrete Aggregates.
   b. C144 - Aggregate for Masonry Mortar.
   c. C150 - Portland Cement.
   d. C618 - Fly Ash and Raw and Calcined Natural Pozzolans for Use in Portland Cement Concrete.
   e. C778 - Standard Specification for Standard Sand.
   f. D512 - Standard Test Methods for Chloride Ion in Water.
   g. D516 - Standard Test Method for Sulfate Ion in Water.
   h. D1556 - Density of Soil In-Place by Sand-Cone Method.
   i. D1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft LBF/ft3 (2700 KN-M/mm3)).
   j. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   k. D4546 Standard Test Methods for One-dimensional Swell or Settlement Potential of Cohesive Soils.
   l. D6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
   m. G51 - Measuring pH of Soil for Use in Corrosion Testing.
   n. G57 – Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.
2. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR Part 1926 - Safety and Health Regulations for Construction.

1.03 SAMPLING AND TESTING

A. Tests of all Contractor-secured materials and products being submitted for approval to determine conformance with all requirements of these specifications including borrow materials (both on-or off-site) proposed for use, shall be performed by an independent, testing laboratory retained and compensated by the Contractor.

B. As materials are incorporated into the Project, on-site and off-site quality control tests will be performed during construction to determine conformance with plans and specifications by an independent testing laboratory retained and compensated by the Contractor. Frequency of on-site and off-site testing is specified in Part 3.

1.04 SUBMITTALS

A. Submit as specified in Division 1.

B. Includes, but not limited to, the following:

1. Test results from laboratory testing of proposed bedding, backfill, and borrow materials.
2. Compaction equipment to be used for fill, trench backfill, and other backfill operations.
3. Warning tape data and sample.
4. Pipe bedding materials data and tests.
5. Qualifications of the Contractor’s independent testing lab.

C. Where selecting an option for excavation, trenching, and shoring design from "OSHA Part 1926," which requires design by a registered professional engineer, submit (for information only and not for Engineer approval) copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems approved and sealed by the registered professional engineer obtained by Contractor.

1.05 JOB CONDITIONS

A. Lines and grades shall be as indicated. Reference points as necessary to permit the Contractor to lay out and construct the work properly are available from the plans.

B. Carefully maintain all reference points and replace as directed by the Owner if disturbed or destroyed.

C. Disposition of Utilities:

1. Existing underground utilities are shown on plans using the best information available at the time of preparation. The exact location, number and limit of existing utilities are uncertain. Contractor shall identify, locate and protect all underground utilities adjacent to or which may be affected by construction under this contract before starting excavation or other site construction activities which could damage utilities.
2. Remove or relocate only as indicated, specified, or directed.
3. Report inactive and abandoned utilities encountered in excavating and grading operations to Owner. Remove, plug, or cap as directed by Owner.
4. Provide a minimum 48 hours’ notice to Owner and receive written notice to proceed before interrupting any utility.

D. Contamination:

1. Contaminated soil and/or groundwater is not anticipated. However, if the Contractor suspects contaminated soil has been encountered during the progress of work by odor or other means, the Contractor shall immediately notify Owner for directions on how to proceed. Material shall be disposed of by Contractor at a location and price approved by Owner.

PART 2 - PRODUCTS

2.01 MATERIALS ENCOUNTERED

A. Materials suitable for use in backfill and fill include material that is free of debris, roots, organic matter, and frozen matter and which is free of stone having any dimension greater than 1/2 the specified layer thickness.

B. Materials shall not exhibit characteristics of high shrink-swell potential as determined from Atterberg Limit tests (ASTM D4318) and/or swell/pressure tests (ASTM D4546).

C. For soils used below structural elements, such as footings, slabs, pavements, and mats, that portion of material passing the No. 40 sieve shall have a liquid limit not exceeding 40 and a plasticity index not exceeding 25 when tested in accordance with D4318.

1. Non-Cohesive Materials:
    a. Materials that are not cohesive include: gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material.
    b. Non-cohesive materials are free-draining materials for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods, and for which generally less than 15 percent by dry weight of soil particles pass a No. 200 sieve.
2. Cohesive Materials:
    a. Cohesive materials include silts and clays generally exclusive of sands and gravel and are materials for which impact compaction will produce a well-defined moisture-density relationship curve.

D. Materials unsuitable for use in backfill and fill include all material that contains debris, roots, organic matter, frozen matter, stone (with any dimension greater than 1/2 the layer thickness), or other materials that are determined by Engineer as too wet or otherwise unsuitable for providing a stable fill, subgrade, or foundation for structures.

E. Materials suitable for backfill of utility trenches and structures including fueling pits shall be as specified for backfill and fill except that no stones or particles may exceed 2-inches.

F. All materials encountered, regardless of type, character, composition and condition thereof shall be unclassified. Estimate quantity of various materials included prior to submitting Bid Form. Rock encountered shall be handled at no additional cost to Owner.

G. Waste material includes excess usable materials and materials unsuitable for use in the work.

H. Borrow materials includes the following:

1. Acceptable fill materials, granular materials, and topsoil obtained from locations arranged for by Contractor and required when sufficient suitable materials are not obtained from excavation and trenching.
2. Obtaining, excavating, handling, and final placement of materials.

2.02 GRANULAR MATERIAL

A. Pipe Bedding Material for Exterior Coated Steel Pipe shall be clean, natural sand conforming to ASTM C144 (masonry aggregate) or ASTM C33 (fine concrete aggregate) with not more than 5% by weight passing the No. 200 sieve. Resistivity tests for sand backfill shall verify the sand has an average wet Resistivity greater than 10,000 ohm-cm as determined by ASTM G57.

	ASTM C33	ASTM C144
Sieve	**Percent Passing**	**Percent Passing**
3/8-inch	100	---
No. 4	95 to 100	100
No. 8	80 to 100	95 to 100
No. 16	50 to 85	70 to 100
No. 30	25 to 60	40 to 75
No. 50	10 to 30	10 to 35
No. 100	2 to 10	2 to 15
No. 200	---------	0 to 5

B. Type “20-30 Sand”:

Sieve Size	Percent Passing
No. 16	100
No. 20	85-100
No. 30	0-5

C. Type “Graded Sand”:

Sieve Size	Percent Passing
No. 16	100
No. 30	96-100
No. 40	65-75
No. 50	20-30
No. 100	0-4

D. ASTM C144, Natural Sand:

Sieve Size	Percent Passing
No. 4	100
No. 8	95-100
No. 16	70-100
No. 30	40-75
No. 50	10-35
No. 100	2-15
No. 200	0-5

2.03 BACKFILL AND FILL MATERIAL

A. Material shall be free of roots or other organic matter, refuse, debris, ashes, cinders, frozen earth, or other unsuitable material.

B. Use suitable material sufficiently friable to provide a dense mass free of voids and capable

of specified compaction.

C. Do not use material containing gravel, stones, or shale particles greater in dimension than 1/2 the depth of the layer to be compacted.

D. Moisture content shall be that required to obtain specified compaction of the soil.

E. Perform any wetting or drying of the material as required to obtain the specified density when compacted.

2.04 WARNING TAPES FOR UNDERGROUND UTILITIES

A. Install warning tapes for the purposes of early warning and identification of buried pipes during future trenching or excavation.

B. Tape shall be plastic, acid- and alkali-resistant polyethylene film, at least 6-inches wide and four (4) mils thick, of the color indicated, and continuously inscribed with at least 1-inch high, black lettering, indicating type of buried line installed:

1. "BURIED JET FUEL LINE BELOW," yellow tape.
2. "BURIED ELECTRIC LINE BELOW," red tape.
3. "BURIED TELEPHONE/COMMUNICATIONS LINE BELOW," orange tape.

C. Use detectable warning tape above all nonmetallic piping. Tape shall be manufactured with protected integral wire, foil backing, or other means of enabling detection to 36-inch depths.

PART 3 - EXECUTION

3.01 EXCAVATION AND TRENCHING

A. Sheeting and Bracing:

1. Use when required for slope stability and where resulting slopes from excavation or trenching might endanger in place or proposed structures or utilities.
2. Provide materials on site prior to start of excavation. Adjust spacing and arrangement as required by conditions encountered.
3. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other approved fill material.

B. Explosives: Blasting will not be permitted.

C. Trenching for Underground Utilities:

1. Side Walls:
   a. Make vertical or sloped within specified trench width limits below a plane 12-inches above the top of the pipe.
   b. Make vertical, sloped or stepped as required for stability, above a plane 12-inches above the top of the pipe.
   c. Excavate without undercutting.
2. Trench Depth:
   a. Excavate to depth sufficient to provide the minimum bedding requirements for the

pipe being placed.

b. Do not exceed depth indicated where conditions of bottom are satisfactory.

c. Increase depth as necessary to remove unsuitable supporting materials as directed.

3. Trench Bottom:
   a. Protect and maintain when suitable natural materials are encountered.
   b. Remove rock fragments and materials disturbed during excavation or raveled from trench walls.
   c. Restore to proper subgrade with trench stabilization material when over excavated. Payment shall be negotiated with Owner for authorized replacement of unsuitable materials. Correct at no additional cost to Owner when trench is over excavated without authority or to stabilize bottom rendered unsuitable through negligence or improper operations.

4. Trench Width:
   a. Excavate trench to a width which will permit satisfactory jointing of the pipe and thorough tamping of bedding.
   b. Unless indicated otherwise, do not exceed following trench widths:
      1) Bottom of trench, minimum width: Pipe OD + 2 feet.
      2) Above plane (12-inches above top of pipe) no maximum limit, however maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods utilized.

5. Fill Areas: Perform trenching only after compacted fill has reached an elevation of not less than one foot above the top of the pipe.

6. Protect open trenches with movable barriers as required to protect the work.

D. Dewatering:

1. Control grading around excavations to prevent surface water from flowing into excavation areas.

2. Drain or pump, as required to continuously maintain all excavations and trenches free of water or mud from any source and discharge to approved drains or drainage channels. Commence when water first appears and continue until work is complete to the extent that no damage will result from hydrostatic pressure, flotation, or other causes.

3. Remove subgrade material rendered unsuitable by excessive wetting or siltation and replace with approved backfill material.

3.02 FILL AND BACKFILL

A. General Fill and Backfill:

1. Construct to the depths, contours, and elevations indicated and as specified, using suitable approved material from excavation and borrowed areas.
   a. Place material in loose lifts not exceeding 8-inches.
   b. Place only on subgrades approved by Engineer.
   c. Remove all debris from excavation prior to placement.
   d. Compact Fill and Backfill to 95 percent of maximum dry density at optimum moisture content as determined by ASTM D1557.
   e. Moisture content shall not be more than 2 percent above or 2 percent below

optimum during compaction. Stricter limits may be required to meet specified density. Obtain compaction by the controlled movement of approved compaction equipment during the placing and grading of layers.

B. Backfilling: Backfill for structures and trenches shall be as specified for general fill and backfill with the following additional provisions.

1. Structures:
   a. Do not backfill around any part of structure until each part has reached specified 28-day compressive strength.
   b. Backfill adjacent to structures only after a significant portion of the structure has been built to resist the imposed load.
   c. Perform backfilling simultaneously on all sides of structures.
   d. Exercise extreme care in the use of heavy equipment in areas adjacent to structures. Equipment operated within 10 feet of any wall shall not exceed 20,000 pounds gross weight.
   e. Material above a 45 degree plane intersecting the footing shall not include rock fragments incapable of passing a 2-inch screen, and no shale whether disintegrated or not.
2. Trenches: Backfill for trenches shall be as specified for general fill and backfill and with the following additional provisions:
   a. Complete promptly upon completion of pipe embedment and approval to proceed.
   b. Use hand methods to a plane 12-inches above top of pipe.
   c. Mechanical methods shall be acceptable where hand backfill is not required.
   d. Until compacted depth over utility exceeds 3 feet, do not drop fill material over 5 feet.

C. Pipe Bedding Material:

1. Place pipe bedding as indicated using bedding material specified.
2. Place pipe bedding material as follows:
   a. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
   b. Add second layer simultaneously to both sides of the pipe with care to avoid displacement.
   c. Complete promptly after placement of pipe.
3. Compact Pipe Bedding Material as follows:
   a. In lifts not exceeding 12-inches of loose material.
   b. Rods, spades, or use pneumatic or vibratory equipment.
      1) As required to obtain not less than 95 percent of maximum density as determined by ASTM D1557.
      2) Throughout depth of embedment.

3.03 WASTE MATERIALS

A. Remove unsuitable materials from work area as excavated.

1. Demolished or excavated materials such as asphalt, concrete, and others which are unsuitable for reuse in the Project (as determined by Engineer) shall become property of Contractor and be disposed of off-Site at locations arranged for and paid for by

Contractor.

3.04 ON-SITE TESTING

A. Contractor shall retain and compensate an independent testing lab to perform the following tests.

B. Contractor shall provide testing laboratory access to work which is to be tested and include in his Bid, all costs for delays associated with the performance of the described testing by the testing lab.

C. Contractor shall notify the Owner's construction representative no less than 24 hours before work is expected to be ready for testing.

D. The method of in-place compaction testing including density and moisture content will be as follows:

1. Density: ASTM D6938 (Nuclear Density) and ASTM D1556 (Sand Cone Density).
2. Moisture Content: ASTM D6938 (Nuclear Moisture).

E. A representative frequency of in-place compaction tests including density and moisture content shall be as follows:

1. At least one test for every 50 yd^3 of backfill placed in trenches.
2. At least one test for every 200 ft^2; but, not less than one test per lift in fill around structures.
3. At least one test when Engineer suspects the moisture content or effectiveness of compaction is not acceptable.
4. In place density may be tested by ASTM D6938 (nuclear) or by ASTM D1556 (sand cone), but at least one ASTM D1556 test shall be performed for every 10 ASTM D6938 test or portion thereof.

F. Fill failing to meet required densities or moisture contents shall be scarified and re-compacted as necessary to achieve specified results at no additional cost to Owner.

G. Removal of in-place material and replacement with approved new material will be required if scarifying and re-compaction do not produce the required densities.

H. Perform at least one ASTM D1557 (Modified Proctor) test on each type of soil used in fill or backfill operations during construction.

1. Sample shall be taken from trenches or other excavations as directed by Engineer and should be generally representative of materials encountered and used for backfill or fill.

2. Perform one test at the beginning of excavation and one additional test when material properties vary (wetter, dryer, more granular, or other conditions) from the material initially tested.

3. Additional tests shall be performed when directed by the Engineer.

I. Perform at least one ASTM D1557 (Modified Proctor) test for every 2500 yd^3 of material placed.

3.05 MAINTENANCE AND CLEAN-UP

A. Protect newly graded areas from actions of the elements.

B. Settling or erosion occurring shall be filled and repaired and grades reestablished to the required elevations and slopes.

C. Keep paved areas clean. Promptly remove rock or dirt dropped upon paved surfaces by sweeping, washing, or other methods acceptable to Engineer.

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 31 20 01

SECTION 335243

FUEL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Furnish all labor, equipment, and material for the complete installation of the aircraft hydrant fueling system indicated and specified.

B. Contractor shall obtain and pay for all permits and water meters required by this Contract unless specified otherwise.

C. Due to the complexity of this project, critical phasing, and imperative need for the fueling system to remain 100 percent on-line during construction, all Work related to the fuel system specified in Division 33 and shown on the Plans shall be performed by an experienced fueling system contractor/subcontractor meeting the following qualifications:

1. The contractor/subcontractor shall be a mechanical contractor experienced in the construction of aircraft fueling systems.
2. The contractor/subcontractor shall have completed at least three aviation fueling projects greater than or equal to $5,000,000 each over the last ten years.
3. The subcontractor shall be capable of bonding all the fueling work in Division 33 and shown on Drawings.

D. The Contractor shall be responsible for the draining and removal of fuel from existing and/or new piping as required for demolition, new construction, phasing, etc. Fuel shall be returned to Owner. Refer to Section 335253 for additional requirements.

1.03 RELATED REQUIREMENTS

A. Section 334713.13 - Basin Liners For D2 Fuel Flushing Stations.

B. Section 335244 - Identification of Fuel Piping and Equipment.

C. Section 335245 - Fuel System Pipe, Connections, and Installation.

D. Section 335246 - Fuel System Coatings for Corrosion Protection.

E. Section 335247 - Fuel System Valves.

F. Section 335247.13 - D2 Flushing Station Valves.

G. Section 335248.13 - D2 Fuel Flushing Station Accessories.

H. Section 335252 - Fuel System Hydrant Components.

I. Section 335253 - Inspection, Testing and Flushing.

J. Section 335253.13 – D2 Flushing Station Operations.

1.04 REFERENCE STANDARDS

A. Refer to the individual Sections for fuel systems.

1.05 SUBMITTALS

A. Submit as specified in Division 1.

B. Submittals shall constitute a representation to Owner and Engineer that Contractor has both determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data or he assumes full responsibility for doing so, and that he has coordinated each Submittal with the requirements of the Work and the Contract Documents. Contractor certifies that the Material and Equipment shown and marked on the Submittals are in compliance with the Contract Documents and can be installed, operated, and maintained in the allocated space.

C. Include, but not limited to, the following:

1. Piping fabrication drawings.
    a. Include in-plan view of all systems piping 2-1/2 inches and larger. Provide isometrics for piping systems or tubing 2 inches in diameter and smaller.
    b. Show the actual Equipment furnished, Equipment location by dimension, and connections.
    c. Dimension pipelines in plan view and locate in elevation. Indicate support locations.
    d. Submit before fabrication is begun.
    e. The pipe routing and supports shown are within the stress limits of ASME B31.3. Changes in piping configuration resulting from Contractor's selection of Equipment, or a preferred method of pipe routing, will require detailed stress analysis. For changes in the design documents by Contractor, stress analysis and support design shall be reanalyzed for all anticipated loads including gravity, thermal, pressure, and seismic in accordance with ASME B31.3. These calculations shall be performed and sealed by a Colorado-registered Professional Engineer and submitted as Submittals for review by Engineer.
2. Coating Materials.
3. Fiberglass Pit Assemblies.
4. Pipe, Fittings, and Accessories including certificates of origin, material certificates and mill test reports.
5. Testing and Examinations:
    a. Pressure Testing Records.
    b. Nondestructive Examinations (NDE) Records.
    c. Qualifications of Examiners and NDE Personnel.
6. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
7. Instruction books and maintenance manuals include, but not limited to, the following:
    a. Control Valves.

b. Manual-Operated Valves.
c. Check Valves
d. Pressure Gauges.
e. Fittings and Specials.
f. Prefabricated Valve Pits and Covers.
g. Installation and Erection Details.
h. Welding qualification and procedures.

8. Bind all instruction books and manuals complete in three-ring binders with hard durable covers clearly and permanently identified with Contract name and number.

9. Each manual shall include the Equipment purchase order.

10. Refer to related Sections for further definition of submittal requirements.

1.06 QUALITY ASSURANCE:

A. All Equipment and Materials shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such Equipment and Materials for a minimum of 5 years.

B. When two or more units of the same class of Equipment are required, they shall be products of a single manufacturer.

C. Unless otherwise specified, all items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with maximum operating condition of 275 psig, within a temperature range of -20ºF to 100ºF, and having a specific gravity of 0.81.

D. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any pipe, flanges, fittings, bolts, or nuts of foreign manufacture. All pipe, flanges, fittings, bolts, and nuts shall be manufactured in the United States of America, and Contractor shall warrant the U.S.A. origin of all such items. Pipe, flanges, and fittings shall bear a stamp attesting to their place of origin. Contractor shall provide written certification from the manufacturer as to the origin of all pipe, flanges, fittings, bolts, and nuts installed on the Project. If at any time Owner determines that any pipe, flanges, fittings, bolts, or nuts are not of U.S.A. origin, Owner shall be entitled to replace all pipe, flanges, and/or fittings, and/or bolts and/or nuts (as the case may be) without the need for individual testing for conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Receive, unload, check, and store in suitable facilities all Equipment and Materials.

B. Examine all Equipment and Materials for concealed damage and report any damage to Owner.

C. Be responsible for the safety and protection from loss or damage of all Equipment and Materials received until the Work is complete.

D. Contractor's means and methods of installation shall not damage Materials and Equipment.

E. Pay all demurrage charges and claims for damage to vehicles resulting from the unloading operation.

F. Protect all Equipment and Materials during storage and prior to start-up which shall include the coverings of all openings, protection against rust and other damage, and other similar measures. Equipment may be stored outdoors only when approved. Contractor shall protect all coated pipe and fittings from ultraviolet deterioration.

G. Furnish all labor, Materials, and Equipment necessary to make a complete installation as indicated and specified.

H. Provide all necessary supports, brackets, or foundations for properly installing all Equipment or temporary piping.

I. Coordinate with the other trades before installation of Materials. Extra charges shall not be approved for interferences due to lack of coordination.

J. All Equipment shall be properly aligned, adjusted, and lubricated before final acceptance.

K. Spot paint all Equipment where the shop paint has been damaged or flaked off. Finish painting of all exposed piping and mechanical Equipment is specified in Section 335246 unless otherwise specified.

L. Furnish all bolts, studs, nuts, and gaskets for makeup of all connections to the Equipment and replace all gaskets damaged during storage, inspection, cleaning, or placing into service.

M. Retighten all threaded and bolted connections after installation.

1. This applies to Owner-furnished equipment as well and shall be accomplished by Contractor at no additional cost to Owner.

N. Contractor shall be responsible for all added expenses due to his choice of Equipment.

O. All Materials shall be installed at times necessary to avoid delays in construction.

P. All work in existing buildings shall be done on a schedule as approved by Owner to assure minimum interruptions.

Q. Provide vents and drains at high and low points where indicated and as required elsewhere for satisfactory draining and venting of fuel systems. For above grade piping systems, high point vents shall consist of a sockolet, 3/4-inch socket weld x threaded ball valve and plug or cap, unless otherwise indicated. Low point drains for aboveground piping systems shall be similar except ball valve shall be 2-inch, unless otherwise indicated.

R. All connections to valves 3 inches and larger shall be made with flanges unless indicated otherwise; all connections to Equipment shall be made with unions or flanges.

S. Piping shown on the Drawings is partially diagrammatic and not necessarily the exact routing. Provide all necessary bends that may be required to avoid conflict and interferences. Bends required in addition to those indicated shall be submitted for approval by Engineer prior to fabrication.

T. Installation shall equal or exceed the minimum requirements of the applicable codes and these Specifications; however, where local codes and ordinances are more stringent, they shall govern.

U. Verify all measurements and location of existing facilities and underground piping before commencing work.

V. Certain permanent and temporary piping and equipment systems shall be installed, inspected, tested, flushed, and placed into operation prior to complete installation of the Work. Contractor shall provide all gaskets, companion flanges, bolting, weld caps, temporary blank-off plates, temporary piping systems, labor, materials, and accessories required to place these systems into operation.

3.02 PIPE TRENCH:

A. Excavation, backfill, and compaction of pipe trench shall conform to Sections Section 312001 - Site Preparation and Earthwork For Fuel Systems of the Specifications.

3.03 WELDING QUALIFICATION AND APPROVAL:

A. Procedure: Upon award of the Contract, the Welding Procedure Specification (WPS) that is intended to be used on the job shall be submitted to Engineer.

B. Submit certified copies of the Procedure Qualification Records (PQR) as evidence that the intended procedures have been qualified in accordance with the latest revisions of the following codes:

1. ASME B31.3 - Process Piping.
2. ASME Boiler and Pressure Vessel Code, Section I and Section IX.

C. Design for the conditions of this Contract. Be complete and specific, and where necessary, differentiate between shop and field welding.

D. Welder Performance Qualification (WPQ) Test Certificates:

1. Furnish welder performance qualification test certificates for positions 2G and 5G or 6G, made in strict compliance with the above codes.
2. Submit current qualification test records for each welder on the Project and keep record files current. Welder shall have been qualified to the WPS within the last six months.
3. Welder Performance Qualification test certificates shall be submitted to Engineer before the welder shall be permitted to work on the Project.
4. Welders shall be certified for the type of pipe material welded.

5. Submit copies of the WPQ test certificates to Engineer for review as specified for Submittals.
6. Welders and welding operators shall be qualified without the use of backing rings for all welding.

E. Submit WPS, PQR and WPQ on the forms contained within Appendix B of the ASME Boiler and Pressure Vessel Code, Section IX.

1. Stamp all welds with the welders or welding operators' identification number or symbol.

F. Costs: Costs incident to procedure and welders' qualification tests shall be assumed by Contractor.

3.04 FIELD TESTS:

A. Service and Test Engineers:

1. Furnish the services of experienced factory service engineers for at least the minimum time specified and additional time as required to perform and/or supervise the erection, start-up, testing and placing into successful operation all piping systems and equipment and to instruct Owner's personnel in the operation of equipment.
2. Travel and living expenses shall be paid by Contractor.
3. The services of the service engineer shall be provided upon request at the times required by Owner.
4. The service engineer shall be directly responsible to Owner and when requested shall make daily reports to Owner.
5. The service engineer's performance shall be satisfactory and acceptable to Owner. Unsatisfactory performance time shall not be considered as qualified service time.
6. The service engineer shall be replaced at the request of Owner.
7. Upon arriving or leaving the site, the manufacturer's service engineer shall report to Owner's Resident Project Representative.
8. The service and test engineers required to conduct start-up and tests of the systems and Equipment furnished shall be called to the Site only after the installation is complete and ready, and Owner has been notified at least 24 hours in advance.

B. Testing:

1. Perform all tests as specified, recommended by the manufacturer, and required by the codes. Additional tests deemed necessary by Owner shall be performed to ensure proper operation and function of the Equipment furnished, and to certify that the furnished Equipment meets the performance specified.
2. Perform tests before Work is concealed and only after notifying Owner that items are ready. All tests shall be witnessed by Owner.
3. Conduct tests in a safe and orderly manner with qualified trained personnel in accordance with safety codes and local ordinances.
4. Obtain all necessary approvals, acceptances, and permits.
5. Correct all deficiencies resulting from tests.

6. Equipment and System Performance, and Acceptance Tests:
   a. Contractor shall coordinate and schedule all performance and acceptance tests and ensure that all required factory service engineers and test personnel will be present. The required test equipment and instruments will be available and calibrated for the tests.
   b. Contractor shall conduct all performance and acceptance tests and provide all test labor.
   c. Furnish all instruments, thermometers, and gauges required for testing. If the accuracy or completeness of installed instrumentation is not sufficient, Contractor shall provide additional instrumentation.
   d. Provide all pipeline connections, valves, temporary connections, and lines as specified or as required for testing.
   e. Make all performance tests as soon as practical after successful operation to determine if the Equipment furnished meets the Specifications and guarantees.
   f. Notify Owner at least one week in advance before the test. Contractor shall submit a written notice containing the test schedule, test procedure, and the personnel to be present at the test.
   g. Contractor shall prepare a typewritten report of the test, including all test log sheets, and submit to Owner as specified.
   h. Contractor shall furnish electrical power, water, and operating personnel for start-up, operating, and performance testing.
   i. In the event of failure of any Equipment or systems specified in this Contract to operate and perform as specified, or if the Equipment fails to meet the performance guarantees provided for in this Contract, Owner shall have the right to operate the system or Equipment until such defects have been remedied by Contractor, and the guarantees complied with. In the event that defects necessitate the rejection of the system or Equipment, Owner shall have the right to operate the Equipment without additional cost until such time as new Equipment is provided to replace the rejected Equipment. Replacement of the Equipment shall be coordinated and scheduled with Owner.
7. Tests and Checks of Piping Systems for Acceptance:
   a. Inspection, Testing, and Flushing shall be as specified in Section 335253.

3.05 FACTORY TESTS

A. For factory testing of Equipment, refer to specific Sections of Division 33 where Equipment is specified.

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 335243

SECTION 335244

IDENTIFICATION OF FUEL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the identification of fuel piping and equipment.

1.03 RELATED REQUIREMENTS

A. Protective Coatings: Section 335246 "Fuel System Coatings for Corrosion Protection."

1.04 REFERENCE STANDARDS

A. American Petroleum Institute:

1. Recommended Practice 1637 - Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Service Stations and Distribution Terminals.

B. American Society of Mechanical Engineers (ASME):

1. A13.1 - Scheme for the Identification of Piping Systems.

C. Energy Institute (Institute of Petroleum - IP):

1. EI 1542 - Identification Markings for Dedicated Aviation Fuel Manufacturing and Distribution Facilities, Airport Storage and Mobile Fueling Equipment.

D. Federal Aviation Administration:

1. Advisory Circular 150/5230-4 - Aircraft Fuel Storage, Handling and Dispensing on Airports.

E. National Fire Protection Association (NFPA):

1. 704 - Identification of the Hazards of Materials.

1.05 SUBMITTALS

A. Submit as specified in Division 01.

1.06 INCLUDE, BUT NOT LIMITED TO, THE FOLLOWING:

1. Proposed identification scheme including plans identifying proposed piping and equipment label locations.
2. Catalog cuts.

3. Sample(s) representative of labels specified.
4. Color chips.
5. Site fire protection “map”.

1.07 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards: Comply with listed Codes and Standards for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.01 IDENTIFICATION OF PIPING

A. Materials: Pressure-sensitive type labels or paint/stencil as specified herein.

B. Sizing of Pipe Markers, Arrows:

1. Conform to ASME A13.1 as a minimum for legend letter size and length of color field based upon outside diameter of pipe or covering if applicable.
2. Size of arrows shall be coordinated with pipe marker and letter size and be based upon outside diameter of pipe or covering if applicable.

C. Color Coding:

1. Jet A piping and AVGAS systems:

a. Label in accordance with EI 1542 and FAA Advisory circular 150/5230-4. Label or stencil flow direction on piping.

Provide pressure sensitive type labels, Gammon Technical Products GTP-2135-5 JET-A.

2.02 VALVE IDENTIFICATION MARKERS

A. Provide identification markers for all piping and valves as described below. Permanently install in easily visible locations.

B. Valve Tags:

1. Tags shall be 1-3/8-inch-diameter brass or stainless steel with 1/4-inch high depressed black filled letters attached with brass or stainless-steel S-hooks and chains if required. Bead chain is not allowed.
2. Use Engineer-approved numbering system with complete list and description of each number.
3. Provide valve tags for all valves, including Owner-furnished valves.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean area of surface to receive label or other pressure-sensitive item free of oil, grease, dust, dirt, or other substances which would affect adhesion.

B. On painted surface, install label only after coating system is complete and dry.

3.02 LOCATIONS

A. Piping Labels:

1. Use proper label type suitable for interior or exterior location as applicable.
2. Locate labels on piping near connections to equipment, adjacent to valves or fittings, and at intervals not to exceed 25 feet.
3. For piping with arrows, indicate direction of flow. Place arrows adjacent to or below labels, depending upon visibility. For dual-flow piping, indicate both directions.
4. Locate legends to be visible from normal line of vision above floor finish or grade level.
5. Replace labels which do not adhere properly.

B. Equipment Identification:

1. Identification should be visible from normal operating position, platform, and control room.
2. Location of identification shall be approved by Owner.

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 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 335244

SECTION 335245

FUEL SYSTEM PIPE, CONNECTIONS, AND INSTALLATION

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. This Section covers aircraft fueling system piping, fittings, welded and screwed connections, qualification procedures, welding procedures, materials, radiographing (and other nondestructive testing) requirements, and construction requirements.

B. Belowground piping shall be of conventional single wall construction with pipe and fittings as specified herein for "CARRIER PIPE."

C. All materials, items, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating Rating of 275 psig at 100ºF and a specific gravity of 0.81 ±0.05.

D. All end connections on piping and fittings to be welded shall be prepared for butt welding, without backing ring. Butt welding end preparation shall conform to ASME B16.25.

E. Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any pipe, flanges, fittings, bolts, or nuts of foreign manufacture. All pipe, flanges, fittings, bolts, and nuts shall be manufactured in the United States of America and Contractor shall warrant the U.S.A. origin of all such items. Pipe, flanges and fittings shall bear a stamp attesting to their place of origin. Contractor shall provide written certification from the manufacturer as to the origin of all pipe, flanges, fittings, bolts, and nuts installed on the Project. If at any time Owner determines that any pipe, flanges, fittings, bolts, or nuts are not of U.S.A. origin, Owner shall be entitled to replace all pipe, flanges, and/or fittings, and/or bolts and/or nuts (as the case may be) without the need for individual testing for conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

1.03 RELATED REQUIREMENTS

A. Section 312001 - Site Preparation and Earthwork for Fuel Systems.

B. Section 334713.13 - Basin Liners for D2 Fuel Flushing Stations.

C. Section 335243 - Fuel System General Requirements.

D. Section 335244 - Identification of Fuel Piping and Equipment.

E. Section 335246 - Fuel System Coatings for Corrosion Protection.

F. Section 335247 - Fuel System Valves.

G. Section 335247.13 - D2 Flushing Station Valves.

H. Section 335248.13 - D2 Fuel Flushing Station Accessories.

I. Section 335252 - Fuel System Hydrant Components.

J. Section 335253 - Inspection, Testing, And Flushing.

K. Section 335253.13 - D2 Flushing Station Operations

1.04 REFERENCE STANDARDS:

A. American Petroleum Institute (API):

1. Spec 5L - Line Pipe.

B. American Society of Mechanical Engineers (ASME):

1. B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
2. B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
3. B16.20 - Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed.
4. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
5. B16.25 - Buttwelding Ends.
6. B16.47 - Large Diameter Steel Flanges.
7. B16.5 - Pipe Flanges and Flanged Fittings.
8. B31.3 - Process Piping.
9. B36.10M - Welded and Seamless Wrought Steel Pipe.
10. BPVC Section IX – Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

C. American Society for Testing and Materials (ASTM):

1. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. A105 - Carbon Steel Forgings for Piping Applications.
3. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
4. A139 - Electric-Fusion (Arc) - Welded Steel Pipe (NPS 4 and Over).
5. A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
6. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
7. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
8. A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
9. D229 - Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation.

1.05 SUBMITTALS

A. Submit as specified in Section 335243.

1.06 QUALITY ASSURANCE:

A. All pipe and piping materials shall be produced by a manufacturer acceptable to Owner.

PART 2 - PRODUCTS

2.01 FUEL CARRIER PIPING MATERIALS:

A. Pipe shall be ASTM A53 Grade B, ASTM A106, Grade B or API 5L Grade B, seamless. Stamp all pipe and stencil/label coated pipe with specification and grade. Material certificates and mill test reports shall be provided for all piping.

B. Pipe 2 inches and smaller shall be seamless Schedule 80, pipe 2-1/2 inches through 10 inches shall be Schedule 40, and 12 inches or larger shall be 3/8- inch 0.375-inch wall thickness (Standard Weight).

C. All buried carrier piping shall have full penetration welded connections. Socket-weld connections shall be used for 2 inches and smaller pipe in pits and aboveground piping except for connections to threaded valves, unions, and other equipment. Threaded and flanged connections shall be prohibited on all buried piping.

D. Pipe or fittings in the fuel piping systems shall not be galvanized.

E. Mill Cleaning and Coating of Pipe:

1. All carrier pipe 2-1/2 inches and larger and fittings 6 inches and larger shall be internally epoxy lined at the mill as specified in Section 335246.
2. All single-wall carrier pipe and fittings and containment pipe and fittings shall be externally coated as specified in Section 335246.
3. Clean inside and outside of pipe and fittings by sand or grit blasting or pickling to remove all mill scale.
4. Apply in the mill an approved rust preventive coating to the interior and exterior of pipe and fittings immediately after cleaning. Rust preventive shall be approved by Owner and applied as recommended by the manufacturer. Rust preventive coating may be deleted from the pipe interior if pipe is internally epoxy lined immediately after cleaning. Rust preventive coating may be deleted from the pipe exterior if the pipe is externally epoxy coated immediately after cleaning.
5. The ends of the pipe shall be capped at the factory using suitable galvanized metal or plastic caps, secured with a double wrap of 2 inch-wide pressure sensitive tape.

2.02 FITTINGS FOR WELDED CARRIER PIPE

A. Butt welding type carbon steel, ASTM A234 Grade WPB, ASME B16.9 for sizes 2-1/2 inches and larger. Wall thicknesses shall match pipe.

B. Socket welding Class 3000 forged steel, ASTM A105, conforming to B16.11, for sizes 2 inches and smaller. Butt weld fittings conforming to ASME B16.9 in lieu of socket weld are acceptable for 2 inch and smaller.

C. Elbows shall be long radius unless noted otherwise.

D. Changes in direction of pipe of other than 45 degrees or 90 degrees shall be made as follows:

1. With long radius weldells, cut to the proper angle and shop beveled.
2. Or, at the option of Contractor, with long radius pipe bends. Pipe roundness shall be maintained to factory tolerance for straight pipe lengths. Submit Shop Drawings of all bends and bending procedures for approval by Engineer.
3. Bends of 2 degrees or less may be miter joints.

E. Welded Branch Connections:

1. Welded branch connections shall be butt welding tees except as described herein and with Engineer's approval.
2. Fabricated tees shall be insert-type weldolets, elbolets, or vessolets. Standard weldolets shall not be used for below ground application**.** Fittings and connections shall provide a smooth and accessible surface suitable for 100 percent nondestructive examination of all welds.
3. Standard weldolets may be used for welded branch connections for aboveground piping.
4. Fabricated branch connections for aboveground piping or piping exposed in pits 2 inches and smaller shall be sockolets, elbolets, or threadolets. Field-fabricated half couplings shall not be used.

2.03 FITTINGS FOR SOCKET-WELD AND THREADED FUEL PIPE

A. Class 3000 forged steel conforming to ASME B16.11.

B. Threads of threaded jointed piping shall be full, clean, sharp, and true.

C. Bushings shall not be used except as noted on the Drawings.

2.04 FLANGES AND GASKETS

A. Flanges shall be standard weldneck type Class 150 forged steel, ASTM A105, and conforming to ASME B16.5, except where Class 300, Class 600, or ASME B16.47 Series B flanges are required to correspond to the equipment to which the piping is joined. ASME B16.47 Series A flanges are acceptable for companion pipe flanges above 24-inch size. Inside diameter of flanges shall be bored to match the inside diameter of the mating piping.

B. Flange facings shall correspond to the equipment to which the piping is joined, and unless otherwise required, shall be standard 1/16-inch raised face flanges.

C. Flange gaskets shall be "Flexitallic Type CGI" using 304 stainless-steel windings with flexible graphite "fire rated" filler, or approved equal, conforming to ASME B16.20. Spiral-wound gaskets shall include inner rings to prevent inward buckling of the stainless-steel windings.

D. Gaskets shall be resistant to the effects of aviation hydro-carbon fuels and manufactured of fire-resistant materials.

E. Full face gaskets shall be used for flat face steel flanged joints. Full face gaskets shall conform to ASME B16.21, 1/8-inch thickness and be of fire-resistant composite material.

F. Ring gaskets shall be used for steel flanged joints with raised face flanges.

G. Gaskets shall be 1/8 inch in thickness.

2.05 FLANGE BOLTS AND NUTS

A. Machine bolts shall be heavy hexagonal alloy carbon steel conforming to ASTM A193, Grade B7.

B. Nuts shall be heavy hexagon alloy carbon steel conforming to ASTM A194, Grade 2H.

C. Stud bolts may be used as required for corresponding equipment.

2.06 FLANGED INSULATING JOINTS

A. Joints shall consist of weldneck companion flanges or a weldneck flange with mating valve flange and a package flange insulation assembly.

B. Gasket assembly shall have a full-face, flat thermosetting molded phenolic or G-10 epoxy glass core with nitrile (Buna-N) flat, full facing on both sides (no O-rings or grooves), 1/8 inch thick for series 150 raised face flanges. Minimum dielectric strength shall be 800 VPM conforming to ASTM D229.

C. Insulating washers shall be G-10. Dielectric strength shall be compatible with minimum insulating values of insulating sleeves and gaskets. Furnish double quantity of insulating and zinc-plated steel washers for "full" insulation of flanges.

D. Insulating sleeves shall be G-10, length as required to match thickness of two series 150 raised face flanges plus insulation. Gasket shall provide "full" insulation of studs, minimum dielectric strength shall be 800 VPM.

E. Install insulating joints at the locations indicated.

F. Flange assemblies shall provide a minimum resistance of 1,000 ohms measured between each stud and both flanges (when dry).

2.07 PIPE SUPPORTS

A. Support design and location shall be as indicated. Refer to Section 335243.

B. Provide complete assemblies adequately rated for the applied loads.

C. Install all required inserts and anchors prior to concrete placement.

D. Expansion bolts shall be Hilti or approved equal.

E. Spacing and arrangements shall conform to ANSI B31.3.

F. Support locations are indicated on the Drawings for pipe sizes 2-1/2 inches and larger only, based on the pipe routing shown. Contractor shall locate and provide supports for piping smaller than 2-1/2 inches in accordance with specified Codes and Standards.

G. Contractors shall provide additional supports as required due to changes in the pipe routing or equipment supplied.

H. Reduce spacing one quarter where changes in direction occur.

I. Pipes run parallel in the same plane may be supported on gang supports.

J. Install to prevent sag or vibration and to adequately support the piping without interfering with inherent flexibility.

K. Make adjustments after systems are placed in operation.

L. Explosion or powder driven fasteners shall not be used.

2.08 WELDING FILLER MATERIALS

A. Welding filler material shall be provided in accordance with the applicable welding procedure specification.

B. Filler materials shall be compatible with the base metal and shall be specified and purchased by ASME BPVC Section IX or AWS classification and chemical composition.

C. Welding electrodes and filler materials shall be properly stored in suitable regulated temperature enclosures in accordance with manufacturer's recommendations. The use of wet or moist electrodes will not be permitted.

2.09 THREADED PIPE JOINT SEALING

A. Either of the two materials specified below may be used for sealing of threaded pipe joints unless otherwise specified. All threaded joints shall be sealed.

B. Screwed Pipe Joint Tape: TFE tape applied to male threads. Tape width, number of wraps, and use of additional paste sealant shall be in accordance with tape manufacturer's recommendations.

C. Screwed Pipe Joint Compound: Use compound which is resistant to the effects of aviation hydrocarbon fuels and Underwriters' Laboratories approved for the application intended.

PART 3 - EXECUTION

3.01 HAULING AND STRINGING PIPE

A. Perform the hauling and stringing of pipe and other materials in such a manner as to prevent damage to pipe and material. If damage is sustained, Contractor shall be responsible for repair or replacement cost.

B. Galvanized metal or plastic caps covering the ends of the pipe shall remain in place until the welding of the pipe. If any caps are not in place, resecure to the pipe ends to prevent dirt, water, and other foreign material from entering.

C. String pipe on right-of-way in such a manner as to cause the least interference with the normal use of the land crossed. Leave gaps at intervals to permit use of land and passage of equipment.

D. Contractor shall promptly repair, at his own expense, all roads, fences, building, or other property damaged by him in the progress of the Work.

3.02 LAYING UNDERGROUND PIPE

A. Lay, embed, and maintain all underground pipelines to the flow-line elevation and grades shown on the Drawings.

B. The full length of each section of pipe shall rest solidly upon the pipe bed of compacted sand with depth as indicated. Sand bags or blocking shall be removed prior to final pipe bedding backfill.

C. Any pipe that has the grade or joint disturbed after being laid shall be taken up and relaid.

D. Do not lay pipe in water or when trench conditions are unsuitable except by written permission of Owner.

E. Anchor pipe during installation to prevent flotation prior to placement in service.

F. When Work is not in progress, securely close open ends of pipe or fittings so that no trench water, earth, or other substance will enter the pipe or fittings.

G. Contractor shall be responsible for maintaining the cleanliness of the piping interior. Water, dirt, or foreign material shall be removed from the piping interior at no additional cost to the Owner.

H. Install pipe so as to be clear of contacts with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures.

I. Where coated fuel pipes cross other pipes, conduits or metallic or structures with a separation of less than 6 inches, install an insulating separator.

J. For utilities without cathodic protection, insulating separators shall be 12-inch by 12-inch by 1/2-inch thick UHMW polyethylene sheets. For utilities with cathodic protection, insulating separators shall be 36-inch by 36-inch by 1/2-inch thick UHMW polyethylene sheets.

3.03 INSTALLATION OF ABOVEGROUND PIPE

A. Install complete with valves, fittings, and accessories and make all necessary connections.

B. Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements.

C. All fabrication and installation shall conform to ASME B31.3.

D. Verify all measurements, and location of existing facilities and underground piping, before

commencing Work. Submit discrepancies for clarification before proceeding with the installations.

E. Arrange all piping with proper slopes, true to line, without sags, traps, or pockets, and pitched to drain at the lowest points so that entire systems can be emptied.

F. Provide high point vents, pump outs, and low point drains as required or indicated on the Drawings.

G. Provide threaded unions where indicated and as required elsewhere to permit satisfactory disassembly of small bore piping for threaded valve and equipment maintenance.

3.04 HANDLING COATED PIPE

A. Storage Racks:

1. Storage rack material shall be 4 to 6 inches in bearing width and placed not less than 10 feet apart.
2. Do not rack pipe 10 inches in diameter and larger more than two sections in height; and pipe 8 inches and under not more than 4 sections in height.
3. Protect all racked pipe by use of suitable padded material between sections.
4. All coated pipe shall be protected from ultraviolet deterioration.

B. Handling Operation:

1. All trucks handling coated pipe shall have properly padded bolsters, chains, and binders so as to not damage the coating.
2. Pipe shall not be rolled off the truck but shall be carefully lowered onto the skids by mechanical equipment.
3. Coated and wrapped sections of pipe must be lifted with slings of approved width and are not to be dragged or pulled into position.

3.05 PIPE CLEANING

A. Clean each joint before welding into the system, to remove all loose debris.

B. Remove materials such as welding rods, dirt, and similar materials, left inside after completion of the lines. Expense incurred by Owner for removal of such objects shall be reimbursed by Contractor.

3.06 GAS FREE CONDITIONS

A. All operations in the construction area that involve open flames, or the possibility of arcing or sparking shall be conducted in a "Gas Free" condition.

B. These operations shall include but not be limited to the following:

1. Use of internal combustion engines not equipped with Underwriters' approved spark and flame eliminators.
2. Use of electric motors or electric devices with arcing brushes or sliding contacts that could produce arcing or sparking.
3. Use of tools which may produce impact sparks.

4. Electric or gas welding.
5. Use of cutting or other torches or other open flame equipment.
6. Holiday testing.
7. Use of equipment with hot surfaces or glowing elements.
8. Use of any other equipment or procedure that could create a fire hazard.

C. Contractor shall monitor the use and suitability of the equipment and procedures on the job and maintain a safe "Gas Free" condition when necessary during construction.

D. Prior to commencing any phase of the Work requiring a gas free condition, Contractor shall make the following provisions:

1. Empty pipes containing fuel and purge of all vapors.
2. Isolate, blank off, and adequately ventilate open piping sections so that no part of the pipe containing fuel or vapors is exposed.
3. Drain and ventilate fuel tanks prior to work inside tanks or on any of the tank connections.
4. Make certain that there are no open pools or reservoirs of fuel exposed in the vicinity of the Work.
5. Perform all other safety precautions necessary to ensure that these operations are conducted in a safe manner in accordance with all applicable codes.

E. Use a combustible gas analyzer to make certain no combustible gas concentrations exist in the construction area when performing these operations.

3.07 PERMITS

A. Provide special permits required for any work under the various sections of this section of the Specifications and pay all permit fees.

3.08 WELDED JOINTS

A. Process: Welding shall be accomplished by the use of gas tungsten-arc welding (GTAW/TIG) process to complete all passes, and shall be in strict accordance with ASME B31.3.

B. Procedure: Upon award of the Contract, submit for review the welding procedures and qualifications that are intended to be used on the job in accordance with Section 335243.

1. Owner reserves the right to request qualification tests be performed at the Job Site for each welder and welding operator on the job, such tests being made in strict compliance with the above code.

C. Costs: Costs incident to these procedures and the welder's qualification tests shall be assumed by Contractor.

D. Inspectors: Shop welding and fabrication shall be subject to the right of Owner to maintain one or more inspectors in the shop or to visit the shop at any time this Work is in progress.

E. Identification:

1. Each welder shall identify his weld with specific code marking signifying his name and

assigned number.

2. Contractor shall maintain a code listing assigned to each welder.

3. Stamp on the pipe using "low stress" steel stamp, or other approved method, not closer than 4 inches to a weld.

F. Butt Welding End Preparation on all Pipe:

1. Conform to ASME B16.25.

2. Shop and field bevels shall be machine cut; manual flame cutting without machine guide shall not be permitted.

G. All welds shall have full penetration and fusion and shall conform to ASME B31.3.

H. Backing rings shall not be used.

I. Align pipe joints with pipe clamps prior to welding. Clamps or other alignment devices shall not reduce the internal pipe diameter.

J. Defective welds shall be repaired in accordance with ASME B31.3 at Contractor's expense.

K. Repairs to defective welds shall not be made prior to authorization. Owner will determine on the basis of the testing laboratory report if repairs may be made or if the entire joint must be cut out and welded again.

L. No weld metal shall project within the piping at completion of the welding.

3.09 RADIOGRAPHING

A. Contractor shall coordinate and arrange for radiography by an approved testing laboratory of all welds on all the underground carrier pipe, piping in pits or vaults, and inaccessible fuel lines, and also a minimum of 10% of selected aboveground welded joints. This shall include all circumferential butt welds and all fabricated branch connections.

B. Testing laboratory shall be selected by and employed by Contractor subject to Owner's approval.

C. The radiographing shall be coordinated by Contractor and conducted at the Project Site such that Owner and the testing laboratory are provided with adequate notice that welds are available for radiographing and all the work required of Contractor in connection with the radiographing is properly completed at no additional cost to Owner. Factory welds of the final carrier pipe shall be radiographed by an approved testing laboratory. Radiography of factory welds may be conducted at the factory site.

D. Reports for both factory and field welds shall be submitted throughout the progress of the Work as described below.

E. All radiographing and subsequent reports shall be in accordance with the requirements of ASME B31.3.

F. Each weld shall be assigned a number. Contractor shall maintain a marked up copy of piping drawings identifying the location and number of each radiographed weld. Upon completion of the Work, these drawings shall be submitted with as-constructed drawings.

G. Radiograph exposure records shall be kept by the testing laboratory which show date, location, area, film number, serial number, film combination, time, source-film distance, angulation, weld number and other pertinent information for each weld radiographed.

H. A summary of this record and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Engineer, and Contractor.

I. All joints shall be left exposed until radiographing and other testing is completed.

J. Welds which do not meet the standards of acceptability as outlined in the above mentioned ASME B31.3, will be judged unacceptable and shall be repaired or cut out and rewelded by Contractor as directed by the testing laboratory, all at no additional cost to Owner. Radiographically reexamine repaired and rewelded joints.

K. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.

L. All the costs of the radiographing at each weld and the accompanying reports and interpretation shall be paid by Contractor and shall be included in the Contract Price. Contractor shall be responsible for coordination and scheduling of the Work.

3.10 MAGNETIC PARTICLE AND DYE PENETRANT TESTING

A. Contractor shall coordinate and arrange for dye penetrant or magnetic particle testing by an approved testing laboratory of all new buried socket-weld connections, weldolet connections to existing hydrant lines, and 10 percent of aboveground socket-weld connections.

B. The dye penetrant or magnetic particle tests shall be conducted on the entire 360-degree circumference of each socket weld, weldolet connection to the existing hydrant system piping.

C. Testing laboratory shall be selected by and employed by Contractor subject to Owner’s approval.

D. The dye penetrant or magnetic particle testing shall be coordinated by Contractor and conducted at the Project Site such that the Owner and the testing laboratory are provided with adequate notice that welds are available for testing and all the Work required of Contractor in connection with the testing is properly completed at no additional cost to Owner.

E. Reports for field welds shall be submitted throughout the progress of the Work as described below.

F. All dye penetrant or magnetic particle testing and subsequent reports will be in accordance with the requirements of ASME B31.3 and Section V of the ASME Boiler and Pressure Vessel Code.

G. Each weld shall be assigned a number. Contractor shall maintain a marked up copy of piping drawings identifying the location and number of each weld. Upon completion of the Work, these drawings shall be submitted with as-constructed drawings.

H. Dye penetrant or magnetic particle testing records shall be kept by the testing laboratory and shall show date, location, area, weld number, and other pertinent information for each weld tested.

I. A summary of this record, and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Engineer, and Contractor.

J. All fittings shall be left exposed until testing is completed.

K. Welds which do not meet the standards of acceptability as outlined in the above mentioned ASME B31.3 will be judged unacceptable and shall be repaired or cut out and rewelded by Contractor as directed by the testing laboratory, all at no additional cost to Owner. Repaired and rewelded joints will then be retested.

L. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.

M. All the costs of the testing at each weld and the accompanying reports and interpretation shall be paid by Contractor and shall be included in the Contract Price. Contractor shall be responsible for coordination and scheduling of the testing work.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Measurement for “6-Inch Coated Jet Fuel Piping for New Hydrant Locations” shall be made per linear foot for work.

B. Measurement for “Double Block and Bleed Pipe Installation” shall be made per each.

PART 5 - PAYMENT

5.01 PAYMENT

A. Payment for “6-Inch Coated Jet Fuel Piping for New Hydrant Locations” will be made at the contract unit price per linear foot for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

B. Payment for “Double Block and Bleed Pipe Installation” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 335245-1, 6-Inch Coated Jet-Fuel Piping for New Hydrant Locations –per combined cost per linear foot and per weld.

END OF SECTION 33 52 45

SECTION 335246

FUEL SYSTEM COATINGS FOR CORROSION PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section covers the field- and shop-applied corrosion protection coatings of exterior and interior surfaces for fuel system piping, pipe supports, valves, fittings, Equipment, concrete valve vault/pit walls and floors, structural steel, and all materials to be located underground. Coating systems are specified by "Protective Coating System" sheets at the end of this Section.

B. All walls and floors of existing\concrete valve vaults (pits) that are modified shall be coated as specified in this Section.

C. Coating includes surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and Equipment. Shop preparation, prime coat, and finish coats to be shop applied, may be specified elsewhere, or referenced to this Section so that a complete system is specified and coordinated.

1. Where surface preparation and first (prime) coat are specified in other Sections to be shop applied such as for structural steel, or Equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat.
2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
3. Where Equipment or Materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
4. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop applied.

D. See Specification Section 335245 for special safety requirements for a "gas-free" condition during certain operations in the construction area.

E. Colors:

1. Colors shall be selected after submittal of approved manufacturer's color Samples.
2. Color of finish coatings shall match accepted color Samples.
3. When second and finish (third and fourth) coats are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat.

1.03 RELATED REQUIREMENTS

A. Section 312001 - Site Preparation and Earthwork for Fuel Systems

B. Section 334713.13 - Basin Liners for D2 Fuel Flushing Stations.

C. Section 335243 - Fuel System General Requirements.

D. Section 335244 - Identification of Fuel Piping and Equipment.

E. Section 335245 – Fuel System Pipe, Connections, and Installation.

F. Section 335247 - Fuel System Valves.

G. Section 335247.13 - D2 Flushing Station Valves.

H. Section 335248.13 - D2 Fuel Flushing Station Accessories.

I. Section 335252 - Fuel System Hydrant Components.

J. Section 335253 - Inspection, Testing, And Flushing.

K. Section 335253.13 - D2 Flushing Station Operations

1.04 REFERENCE STANDARDS

A. Society for Protective Coatings (SSPC):

1. SP 1 - Solvent Cleaning. Removes oil, grease, soil, and other substances. Used with other methods to remove rust, paint, and mill scale.
2. SP 3 - Power Tool Cleaning. Removes loose material. Not intended to remove all scale or rust.
3. SP 5 - White Metal Blast Cleaning. Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
4. SP 6 - Commercial Blast Cleaning. Two-thirds of every 9 square inches free of all visible residues; remainder only light discoloration.
5. SP 7 - Brush-Off Blast Cleaning. Removes only loose material, remaining surface tight and abraded to give anchor pattern.
6. SP 10 - Near-White Blast Cleaning. At least 95% of every 9 square inches shall be free of all visible residues.
7. SP 11 - Power Tool Cleaning to Bare Metal.
8. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
9. QP 3 - Certification Standard for Shop Application of Complex Protective Coating Systems.

1.05 SUBMITTALS

A. Submit as specified in Section 335243.

B. Includes, but not limited to, the following:

1. Schedule of products to be used. Schedule shall include the following information:
   a. Surfaces for system to be applied.

b. Surface preparation method and degree of cleanliness.
c. Product manufacturer, name, and number.
d. Method of application.
e. Dry film mil thickness per coat of coating to be applied.

2. Color charts for selection and acceptance.

C. Technical and material safety data sheets.

D. Field Applicator SSPC-QP 1 certification.

E. Shop Applicator SSPC-QP 3 certification.

1.06 QUALITY ASSURANCE

A. Include on label of container:

1. Manufacturer's name, product name, and number.
2. Type of paint and generic name.
3. Color name and number.
4. Storage and temperature limits.
5. Mixing and application instructions, including requirements for precautions which must be taken.
6. Drying or curing time.

B. Coating applicators shall be SSPC-QP 1 or SSPC-QP 3 certified, as applicable, for shop and field applied coatings.

C. Factory-Applied Pipe Coatings:

1. Coating applicator shall have a minimum of 5 years of certifiable experience in the type of coating Work required.
2. Certification of quality control procedures during application of internal and external coatings shall be submitted to Engineer for review. Certification to include: Surface preparation, film thickness per coat, curing procedures, and holiday testing.

D. Pre-Painting Conference:

1. Within 90 days after Contract award and before Project field painting starts, representatives for Owner, Contractor, coating contractor, and coating manufacturer's technical representative shall meet with Engineer.
2. Agenda for the meeting will include details of coating specifications to ensure understanding and agreement by all parties for compliance.

E. Coating contractor shall certify in writing to Engineer that he has previously applied all the systems in this Specification and has the ability to prepare the surfaces correctly as specified.

1. A coating report shall be completed daily at each phase of the coating system starting with surface preparation. These will be submitted on the form attached at end of this Section.

F. In the event a problem occurs with coating system, surface preparation, or application, coating contractor and coating manufacturer's technical representative shall promptly investigate the problem and submit results to Engineer.

G. Stated VOC shall be unthinned maximum VOC certified by manufacturer. Maximum VOC allowable in this area shall be verified and complied with by coating contractor.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:

1. Deliver in sealed containers with labels and information legible and intact.
2. Allow sufficient time for testing if required.

B. Storage of Materials:

1. Store only acceptable materials on Project Site.
2. Provide separate area and suitable containers for storage of coatings and related equipment.
3. Dispose of used or leftover containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials furnished for each protective coating system shall be compatible to the substrate.

B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.

C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions or product.

D. Internal pipe coating shall be certified by the manufacturer to be suitable for exposure to Jet A fuel.

2.02 COATING SYSTEMS

A. Specified on the "Protective Coating System" sheets at the end of this Section. Systems E-4 and E-5 shall be factory-applied.

2.03 SURFACES AND MATERIALS TO BE COATED

A. System E-4: Internal coating of fuel pipe 2-1/2 inches and larger and fittings 6 inches and larger.

B. System E-5: Exterior of buried fuel piping.

C. System E-12A/E-12: Coating system E-12A shall be used for underground fittings, field

welds, and other large repairs to the exterior of buried piping systems.

D. System E-15: Exterior of pipe, fittings, and valves in underground vaults or pits. All fuel system valves shall be painted black.

E. Concrete Valve Vault Wall and Floor Coating: All walls and floor of concrete valve vaults shall be coated with an amine cured, high solids, catalyzed epoxy with minimum 80 percent solids by volume, in compliance with local VOC requirements.

2.04 FIELD APPLIED HYDRANT PIT COATING:

A. Following completion of the hydrant pits and prior to starting flushing operations, coat the inside of the hydrant pits with a gray, two-component spray-on polyurea coating meeting NACE 6A198 definition for a polyurea coating; BASF Elastocoat C-6430, Sherwin-Williams EnviroLastic AR425, or approved equal.

B. Clean the inside of the hydrant pit, including piping and fittings with bio-degradable cleaner/degreaser.

C. Cover pipe, valve, and blind flange to prevent coating during application process.

D. Surfaces shall be dry before application of coating system.

E. Apply coating following manufacturer’s recommendations. The thickness of the cured primer shall not be less than 0.5 mm.

F. When dry, inspect application and re-coat as required to provide full coverage.

G. Remove protective covering from piping and valve.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparations specifications listed.

1. If grease or oils are present, SSPC-SP 1 shall precede any other method specified.
2. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.
3. Prepare surfaces of field welds, sears, or other damage, and touch up with coating as specified or recommended by manufacturer.
4. Concrete Valve Vault Walls and Floors, following removal of grease and oil as described above, shall be prepared by brush-off blast and vacuumed. All surfaces to be coated shall be dry and clean. Comply with coating manufacturer's recommendations for this specific application.

B. Depth of profile will be as specified for each system, but in no instance shall it exceed one-third of the coating dry film thickness per coat.

C. Prepare only those areas which will receive the first coat of the system on the same day.

3.02 APPLICATION

A. Apply coatings in accordance with coating manufacturer's recommendations.

B. Use properly designed brushes, rollers and spray equipment for all applications.

C. Dry film thickness of each system shall meet the minimum specified but not exceed it more than 20 percent or coating manufacturer's requirements if less.

D. On unprimed surfaces apply first coat of the system the same day as surface preparation.

E. Shop painting shall remain 3 inches away from unprepared surface of any substrate such as areas to be welded or bolted.

F. Concrete Valve Pit Wall and Floor Coating:

1. First Coat: 5-mil dry film thickness.
2. Second Coat: 5-mil dry film thickness.
3. System Total: Minimum 10-mil dry film thickness.
4. On Floor Areas: Before second coat has cured, broadcast 40- to 60-mesh clean silica sand into second coat to achieve slip resistance. Brush off and vacuum excess sand after coating has cured.
5. Comply with coating manufacturer's recommendations for this specific application.

G. Environmental Conditions:

1. Atmospheric temperature must be 50ºF or higher during application, unless approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating curing time requirements.
2. Wind velocities for exterior applications shall be at a minimum and not greater than coating manufacturer's limits.
3. Relative humidity must be less than 85 percent and the temperature of the surface to be painted must be at least 5 degrees above the dew point.
4. Provide adequate ventilation equipment in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
5. Provide temporary enclosures and preheat coating material and surfaces to be coated as recommended by coating manufacturer.

H. Protection:

1. Cover or otherwise protect surfaces not being painted, areas not to be painted, and the work of other trades. Remove protective materials when appropriate.
2. Provide signs to indicate fresh paint areas.
3. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
4. Provide cover to prevent paints from entering orifices in electrical or mechanical equipment.

5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, thinners, and related materials. Dispose of leftover containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.
6. Do not remove or paint over equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 CLEANING

A. Touch up and restore damaged finishes to original condition as required.

B. Remove spilled, dripped, or splattered paint from all surfaces.

3.04 COATING REPAIRS

A. Repair all damages to pipe coating systems before the piping is holiday tested.

B. This includes all cuts, breaks, voids, bruised or scarred spots, or other damage caused prior to delivery, or resulting from handling or installation of the pipe, or from any cause whatsoever.

C. Included also are damaged coatings where new connections are made to existing coated pipes or where existing coated pipes are uncovered or exposed for any reason.

D. Repair the coating where welds are made and where damaged or broken by the installation of instrumentation or other accessories or appurtenances.

E. Repair all holidays detected during inspection of coatings.

F. Repair coating where field welds are made or where otherwise damaged or uncoated as follows:

1. Buried Piping System: Use Protective Coating System E-12A materials and techniques.
2. Exposed Piping Systems: Use Protective Coating System E-15 materials and techniques as applicable.
3. Complete all weld radiography and other NDE for fuel piping joints prior to application of coatings.

3.05 QUALITY CONTROL

A. Inspection:

1. Use wet film gauges to check each application about every 15 minutes in order to correct low or heavy film build immediately.
2. Use dry film gauge to check each coat when dry, and the total system when completed.
3. Use holiday or pinhole detector on metal systems to detect and correct voids when indicated on system sheet.
4. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
5. Check temperature of the substrate at regular intervals to be certain surface is 5ºF or

more above the dew point.

6. Complete coating reports daily using form attached at end of this Section.

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 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 Section 335245 Line Item price.

END OF SECTION 335246

COATING REPORT

Contract Name: _____ Contract No.: _____
Coating Contractor: _____ Foreman: _____

Unit or Surface Identification: _____
Unit or Surface Location: Exterior _____, Interior _____

Surface Preparation:
Date _____; Air Temp _____ºF; Relative Humidity _____%
Method of Surface Preparation: _____
Profile achieved _____ mils (if applicable).

Touch-Up:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity_____%; Dew Point _____ºF
Coating Used _____; Dry Film Obtained _____ mils.

First Coat:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity _____%; Dew Point _____ºF
Coating Used _____; Dry Time Before Recoat _____ hrs.
Dry Film Obtained _____ mils.

Second Coat:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity _____%; Dew Point _____ºF
Coating Used _____; Dry Time Before Recoat _____ hrs.
Dry Film Obtained _____ mils.

Third Coat:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity _____%; Dew Point _____ºF
Coating Used _____; Dry Time Before Recoat _____ hrs.
Dry Film Obtained _____ mils.

Protective Coating System: E-4	
Service:	Internal Pipe Coating, Fuel Systems
Surface Preparation:	SSPC-SP10 with nominal profile depth of 1.5 to 2.5 mils.
First Coat:	High solids, high build, amine-cured epoxy, 55% solids by volume, off-white or similar color. Apply at 5 to 6 mils dry film thickness. 2" cutback or wipeback at pipe ends.
Second Coat:	Same as first coat, except white color. 2" cutback or wipeback at pipe ends.
System Total:	Minimum 10 mils dry film thickness.
Volatile Organic Content:	Maximum per local regulatory requirements.
Inspection:	Check for voids with suitable electric holiday detector operating at proper voltage.

Coating Manufacturer	Product Designation		
	FIRST COAT	TOUCH UP	SECOND COAT
PPG	Amercoat 240	Amercoat 240	Amercoat 240
Carboline	Plasite 9060	Plasite 9060	Plasite 9060
Devoe - AkzoNobel	Devran 744	Devran 744	Devran 744
International	Interline 850	Interline 850	Interline 850
Sherwin-Williams	Shelcote II Flake Filled 920R355	Shelcote II HS 920W355	Shelcote II HS 920W355
Tnemec	Tneme-Liner Series 61	Tneme-Liner Series 61	Tneme-Liner Series 61

Protective Coating System: E-5	
Service:	Pipe Coating, Fusion Bonded Epoxy, Exterior of Buried Pipe (Extended to 6” (150 mm) minimum above finished grade or inside vaults)
Surface Preparation:	Shop: Grit blast to SSPC-SP10, with minimum profile depth of 2.5 mils. Surface shall be clean and dry.
	Field: Grit blast uncoated or damaged coated area to SSPC-SP6. Surface shall be clean and dry.
First Coat:	Shop applied, fusion bonded epoxy powder. Apply at 20 mils minimum dry film thickness. 2" cutback at pipe ends
Second Coat:	Field applied, two component catalyzed epoxy specifically for use with specified first coat and of same color.
System Total:	20 mils dry film thickness.
Inspection:	Check for voids with suitable electric holiday detector operating at proper voltage.

Coating Manufacturer	Product Designation		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
Valspar	PipeClad	PipeClad Patch Compound	Per manufacturer
Axalta (DuPont) Nap-Gard Div.	Nap-Gard 7-2500	Per manufacturer	Per manufacturer
3M, Electrical Specialties Div.	Scotchkote 226N or 6233P	Scotchkote 323 or 327	Per manufacturer

Protective Coating System: E-12	
Service:	Pipe Wrapping System for Exterior of Buried Pipe (Used for interfaces between existing coating systems and System E-12A) Where existing pipe having an external coating system other than FBE interfaces with FBE pipe, apply coating system E-12A to bare steel before application of coating system E-12 is applied.
Surface Preparation:	Clean free of dirt, mil lacquer, wax, oil, grease, rust, millscale, or other foreign material.
First Coat:	Apply primer in a uniform thin film, free of runs, sags, and drips.
Second Coat:	Apply polyethylene tape of proper width for pipe size. Clean same as above, apply primer, and polyethylene joint wrap tape in a spiral fashion with 50% overlap. End joint wrap with final edge directed downward. Tape temperature shall be minimum of 40° F. Overlap end splices 6".
Field Inspection/Repair:	Check for voids with suitable electric holiday detector operating at proper voltage.

Coating Manufacturer	Product Designation		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
Polyken YG111 Pipeline Coatings Carboline Division, The Kendall Co	Polyken Primer 1033A		Polyken No. 930-35 Joint wrap - 35 mil thickness
Tapecoat Company	Omniprime		H35 tape wrap - 35 mil thickness

Protective Coating System: E-12A	
Service:	Pipe Coating System for Exterior of Buried Pipe and Casings (Used for fittings, joints, and repairs)
Surface Preparation:	Clean free of dirt, mil lacquer, wax, oil, grease, rust, millscale, or other foreign material, in accordance with SSPC-SP 10 or as required by coating manufacturer.
First Coat:	Field applied high-solids, fast-drying, surface tolerant epoxy coating. Minimum 78% solids by volume. Apply at minimum of 7 mils dry film thickness per coat.
Second Coat and Third Coats:	Same as first coat.
System Total:	20 mils minimum dry film thickness.
Volatile Organic Content:	Maximum per local regulatory requirements.
Field Inspection/Repair:	Check for voids with suitable electric holiday detector operating at proper voltage.

Coating Manufacturer	Product Designation		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
PPG	Amercoat 240	Same as first coat	Same as first coat
Chase Corporation	TC 7100	Same as first coat	Same as first coat
Denso North America, Inc.	Protal 7200	Same as first coat	Same as first coat

Protective Coating System: E-15	
Service:	Pipe, Fittings, Valves in Underground Pits or Vaults
Surface Preparation:	Shop: SSPC-SP 6 and profile depth 1.5 to 2.5 mils.
	Field: SSPC-SP 6 or 11 and profile depth 1.0 mil minimum.
First Coat:	High solids polyamine or polyamide epoxy coating with minimum 67% solids by volume. Apply at 5 to 8 mils dry film thickness.
Second Coat:	Same as first coat - white color.
System Total:	Minimum 10.0 mils dry film thickness.
Volatile Organic Content:	Maximum per local regulatory requirements.

Coating Manufacturer	Product Designation		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
PPG	Amerlock 2 / 400	Same as first coat	Same as first coat
Carboline	Carboguard 890	Same as first coat	Same as first coat
Devoe – AkzoNobel	Devran 224 HS	Same as first coat	Same as first coat
International	Interseal 670 HS	Same as first coat	Same as first coat
Sherwin-Williams	Macropoxy 646 FC B58W610/B58V600	Same as first coat	Same as first coat
Tnemec	Epoxoline II Series N69	Same as first coat	Same as first coat

SECTION 335247

FUEL SYSTEM VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers valves applicable to the fuel system.

B. Extent of Work shall be as follows:

1. All special valves, pilots, fittings, equipment, and related items, shall meet the following requirements:
   a. Be furnished, installed, tested, and put into successful operation.
   b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and related items, whether shown on the Drawings or not, but required.
   c. Meet the requirements of applicable codes and standards as specified.
2. Piping connected to Equipment which must vary from the Drawings shall be furnished and installed as required to make a complete and workable installation without additional cost to Owner. This requirement includes changes due to the selection of a different Equipment manufacturer than what is indicated on the Drawings, specified, or a design change made by the manufacturer between the time the piping system was designed and the time of installation.
3. Control Valves: Furnish complete with pilots, couplings, tubing, etc.
4. Spare, Replacement, or Additional Parts:
   a. Where spare, replacement, or additional parts are required for the Equipment specified herein, these items shall be delivered to Owner immediately upon receipt at the Site.
   b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
   c. Contractor shall prepare an inventory list of the items delivered to Owner.

C. This Section covers valves related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig, 0ºF to 100ºF, and having a specific gravity of 0.81.

D. Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any pipe, flanges, fittings, bolts, or nuts of foreign manufacture. All pipe, flanges, fittings, bolts, and nuts shall be manufactured in the United States of America and Contractor shall warrant the U.S.A. origin of all such items. Pipe, flanges, and fittings shall bear a stamp attesting to their place of origin. Contractor shall provide written certification from the manufacturer as to the origin of all pipe, flanges, fittings, bolts, and nuts installed on the Project. If at any time Owner determines that any pipe, flanges, fittings, bolts, or nuts are not of U.S.A. origin, Owner shall be entitled to replace all pipe, flanges, and/or fittings, and/or bolts, and/or nuts

(as the case may be) without the need for individual testing for conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

1.03 RELATED REQUIREMENTS

A. Section 335243 - Fuel System General Requirements.

B. Section 335245 - Fuel System Pipe, Connections, and Installation.

C. Section 335244 - Identification of Fuel Piping and Equipment.

D. Section 335248 - Fuel System Accessories.

E. Section 335252 - Fuel System Hydrant Components.

1.04 REFERENCED STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American Society for Testing and Materials (ASTM):

1. A216 – Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.

C. American Society of Mechanical Engineers (ASME):

1. B16.34 - Valves - Flanged, Threaded and Welding End.
2. BPVC Section VIII, Division 1 – Rules for Construction of Pressure Vessels.

D. American Petroleum Institute (API):

1. SPEC 6FA - Specification for Fire Test for Valves.
2. STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-welding.
3. STD 600 - Steel Gate Valves, Flanged and Butt-welding Ends, Bolted Bonnets.
4. STD 607 - Fire Tests for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats.
5. STD 609 - Butterfly Valves, Double-flanged, Lug and Wafer-type.

E. Military Specifications:

1. MIL-STD-810G - Environmental Engineering Considerations and Laboratory Tests.

F. National Electrical Manufacturers' Association (NEMA).

G. A comprehensive list of required project submittals is included in Section 335243 - Fuel System General Requirements. Refer to and modify that list as necessary for specific project.

1.05 SUBMITTALS

A. Submit as specified in Section 335243.

1.06 QUALITY ASSURANCE

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.01 BUTTERFLY VALVES (MONOFLANGE)

A. Valves shall be metal-lined, single-flanged type, drilled and tapped full lug body.

B. Valves shall be certified "fire safe" per API STD 607.

C. Valve shall be suitable for 275-psig working pressure and bubble-tight at differential pressure of 275 psid.

D. Valve body shall be compatible to ANSI Class 150 with a face-to-face dimension or laying length in accordance with API STD 609.

E. The disc shall be "double offset" and shall be capable of bi-directional flow and shall be suitable for dead-end service in both directions.

F. Valve body shall be carbon steel, shaft material of stainless steel, disc shall be 316 stainless steel, with 316 stainless-steel pins for attachment to the shaft. Valve shall have adjustable top packing for the shaft. Top of shaft shall be keyed to allow installation of operator at two positions 90 degrees apart. Valve seat shall be 316 stainless steel with TFE insert material.

G. Valves shall be suitable for installation between 150-pound raised-face flanges.

H. Operators shall be as follows:

1. Valve sizes 4 inches and smaller shall have a 10-position, spring-loaded, squeeze-trigger handle with locking device.
2. Valve sizes 6 inches and larger shall have a weatherproof, self-locking, worm gear operator.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Inspect valve for cleanliness, corrosion, and operability. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.

B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides, and seats made accessible by such actuation. Following examination, return the valve's closure member to the shipping position.

C. Examine threads or flanges on both the valve and the mating pipe for form (i.e., out-of-

round or indentation) and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, defects, and damage.

E. Prior to valve installation, examine the pipe for cleanliness and proper alignment.

F. Replace defective valves with new valves.

3.02 VALVE ENDS SELECTION

A. Unless indicated or specified otherwise, select valves with the following end connections.

1. Sizes 2-1/2 inches and smaller shall be socket weld. Drain and vent valves discharging to atmospheric pressure shall be socket weld by threaded end connections (threads on atmospheric side).

2. Sizes 3 inches and larger: Flanged.

3.03 VALVE AND EQUIPMENT INSTALLATION

A. Install where indicated on the Drawings and in accordance with manufacturer's recommendations.

B. Replace all valves and equipment that prove defective during testing. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.

C. Install all butterfly valves with the disc shaft in the horizontal axis.

D. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.

E. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.04 CLEANING AND PROTECTION

A. Clean all fabricated assemblies and all equipment items thoroughly before operating or testing.

B. Protect equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.05 EQUIPMENT TEST AND CHECKOUT

A. Before equipment installations will be accepted, the equipment shall be tested and demonstrated to be correctly connected and installed.

B. All testing and checkout procedures of the manufacturer shall be carried out completely.

C. All tested equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.

D. Any operating difficulty or defective item as a result of Contractor's work shall be repaired or

replaced and put into proper operation by Contractor immediately.

E. Protect all equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

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 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 Work associated with 335253.

END OF SECTION 335247

SECTION 335252

FUEL SYSTEM HYDRANT COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section covers hydrant components applicable to the fuel system.

B. Extent of Work shall be as follows:

1. All special valves, pilots, fittings, equipment, and related items, shall meet the following requirements:
   a. Be furnished, installed, tested, and put into successful operation.
   b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and other items, whether shown on the Drawings or not, but required.
   c. Meet the requirements of applicable codes and standards as specified.
2. Piping connected to equipment which must vary from the Drawings shall be furnished and installed as required to make a complete and workable installation without additional cost to DEN. This requirement includes changes due to the selection of a different equipment manufacturer than what is indicated on the Drawings, specified, or a design change made by the manufacturer between the time the piping system was designed and the time of installation.
3. Control Valves: Furnish complete with pilots, couplings, tubing, and related items.
4. Spare, Replacement, or Additional Parts:
   a. Where spare, replacement, or additional parts are required for the Equipment specified herein, these items shall be delivered to DEN immediately upon receipt at the Site.
   b. Parts shall be packaged and sealed for long term storage and be securely and visibly labeled as to part, function, and name of equipment to which they apply.
   c. Contractor shall prepare an inventory list of the items delivered to DEN.

C. This Section covers pits, valves and piping accessories related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig, -20^{o}F to 100^{o}F, and having a specific gravity of 0.81 ±0.05.

1.02 RELATED REQUIREMENTS

A. Section 335243 – Fuel System General Requirements.

B. Section 335245 – Fuel System Pipe, Connections, and Installation.

C. Section 335246 – Fuel System Coatings for Corrosion Protection.

D. Section 335247 – Fuel System Valves.

E. Section 335253 – Inspection, Testing and Flushing.

F. Division 26 – Electrical Work.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

B. American Society of Mechanical Engineers (ASME):

1. B16.11 - Forged Fittings, Socket-Welding and Threaded.
2. B16.34 - Valves - Flanged, Threaded and Welding End.
3. BPVC Section IX – Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

C. American Petroleum Institute (API):

1. 600 - Steel Gate Valves, Flanged and Buttwelding End.
2. 607 - Fire Tests for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats 609 - Butterfly Valves, Lug Type and Wafer Type.
3. 610 - Centrifugal Pumps for General Refinery Service.
4. 1529 - Aviation Fueling Hose.
5. 1581 - Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators.
6. 1584 - Four-Inch Hydrant System Components and Arrangements.

D. American Bearing Manufacturers' Association (ABMA).

E. Factory Mutual Engineering Division (FM).

F. National Electrical Manufacturers' Association (NEMA).

G. Military Specifications:

1. MIL-C-4556 - Coating, Kit, Epoxy for Interior of Steel Fuel Tanks.
2. MIL-R-6855 - Rubber, synthetic, sheets, strips, molded, or extruded shapes.

H. Local governing code.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves and Equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any pipe, flanges, fittings, bolts, or nuts of foreign manufacture. All pipe, flanges, fittings, bolts, and nuts shall be manufactured in the United States of America, and Contractor shall warrant the U.S.A. origin of all such items. Pipe, flanges, and fittings shall bear a stamp attesting to their place of origin. Contractor shall provide written certification from the manufacturer as to the origin of all pipe, flanges, fittings, bolts, and nuts installed on the Project. If at any time DEN determines that any pipe, flanges, fittings, bolts, or nuts are not of U.S.A. origin, DEN shall be entitled to replace all pipe, flanges, and/or fittings, and/or bolts and/or nuts (as

the case may be) without the need for individual testing for conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

PART 2 - PRODUCTS

2.01 HYDRANT VALVE

A. Valve shall be 4-inch cast ductile-iron body with Class 150 ASME inlet flange, and outlet adapter shall conform to API Bulletin 1584, 4th Edition.

B. Valve shall have an air-operated pilot valve, to open and close valve.

2.02 HYDRANT FUEL PIT ASSEMBLY

A. General Requirements: Assembly to be complete with shutoff valve, hydrant pit valve, strainer, and piping accessories to be installed in a concrete pavement apron, suitable for interfacing the fixed fuel system components with the hydrant fueling vehicle.

B. Performance: Designed to permit a fueling flow rate of 1,000 gpm. Liquid to be jet fuel with a specific gravity of 0.81 +0.05.

C. Construction:

1. Pits shall be side entry.
2. Body shall be one-piece molded fiberglass, with built-in concrete anchors.
3. Pit shall have sealed interior pipe entry with steel sleeve encapsulated in fiberglass. Sleeve penetrations shall be suitable for segmented mechanical seals (total of two per pipe penetration) and installation of heat shrink boot seals on the exterior of the pipe penetration. Refer to Section 335245 for segmented mechanical seal specifications and additional requirements.
4. Cover: Cast aluminum water-resistant hinged assembly, water-tight rubber gasket on the underside, 30-pound maximum, one-hand lift weight, 120-degrees minimum door opening, completely removable cover.
5. Provide deep-dish hand hole in cover to permit opening by gloved hand.
6. Cover assembly to be tested at 1,000 psi over 200-square-inch footprint with a maximum acceptable full-load deflection of 0.100-inch, and cover deflection rebound data shall result in a maximum of 0.010-inch after a 740-psi test load has been applied and released. Covers must be free of visual shrink porosity cavity areas, weldments, filler, and paint. A previous independent certified testing laboratory report for the cover assembly shall accompany the Submittal data for the service pit. Weight-bearing flange surfaces of both the pit and cover shall be machined flat to a total indicator reading of +0.010-inch for flatness to assure uniform weight distribution.
7. Entire cover assembly and pit as installed shall be capable of accommodating wheel loads of any aircraft in commercial service.
8. Hydrant pit assembly shall include the following valves and piping materials. Installation shall be as indicated on the Contract Drawings:
    a. Butterfly Valves (Monoflange):
        1) Valves shall be POSI-SEAL International "Phoenix III," Keystone "K-LOK" or

approved equal.

2) Valves shall be metal-lined, single-flanged type, drilled and tapped, full lug body.
3) Valves shall be certified "fire safe" per Oil Companies Materials Association (OCMA) Specification No. FSV.1 and/or API-607.
4) Valve shall be suitable for 275-psig working pressure, bubble-tight at differential pressure of 275 psig, and a maximum shutoff pressure of 300 psig.
5) Valve body shall be compatible to ASME Class 150 with a face-to-face dimension or laying length in accordance with API-609.
6) The disc shall be capable of bidirectional flow at the same flow characteristics.
7) Valve body shall be carbon steel, shaft material of stainless steel, disc shall be 316 stainless steel, with 316 stainless steel pins for attachment to the shaft. Valve shall have adjustable top packing for the shaft. Top of shaft shall be keyed to allow installation of operator at two positions 90^{o} apart. Valve seat shall be 316 stainless steel with TFE insert material.
8) Valves shall be suitable for installation between 150-pound raised-face flanges. The valve manufacturer shall provide cadmium-plated ASTM A325 carbon steel cap screws.
9) Provide lever operators.

b. Strainer:
   1) Strainer shall be Dabico, Inc., Model HPS-4.
   2) Material of construction shall be 16-gage, No. 304 stainless steel with 3/16-inch-diameter holes on 1/4-inch centers.

c. Hydrant Pit Valve:
   1) Hydrant pit valves shall be a THEIM F353AF or Carter 6055AE.
   2) Valve shall be 4-inch cast-steel body with 150-pound ANSI inlet flange and conform to API Bulletin 1584 on the outlet flange.
   3) Valve shall have an air-operated pilot valve.

d. Product identification shall be in raised letters in the cover door. Identification shall be "FUEL."

2.03 VAULT ACCESS COVERS

A. General Requirements: One-piece fiberglass frame complete with aluminum lid and step-down platform.

B. Performance: Designed to permit access to fuel system concrete vault and pipe risers.

C. Construction:

1. Cover assemblies shall be manufacturer standard dimensions of approximate size indicated on structural plans.

2. Frame shall be one-piece molded fiberglass, with built-in concrete anchors. Provide removable step-down platform. Modified platform required for vent and drain access lid.

3. Cover: Cast-aluminum hinged door assembly, 30-pound, one-hand lift weight, 90 degrees door opening, water-resistant design.
4. Provide deep-dish hand hole in cover to permit opening by gloved hand.
5. Cover assembly to be tested at 1,000 psi over 200-square-inch footprint with a maximum acceptable full-load deflection of 0.100-inch, and cover deflection rebound data shall be given at a maximum of 0.010-inch after a 740-psi test load has been applied and released. Covers must be free of visual shrink porosity cavity areas, weldments, fillers, and paint. A previous independent certified testing laboratory report for the cover assembly shall accompany the Submittal data for the service pit. Weight-bearing flange surfaces of both the pit and cover shall be machined flat to a total indicator reading of +0.010-inch for flatness to assure uniform weight distribution.
6. Entire cover assembly and pit as installed shall be capable of accommodating wheel loads of any aircraft in commercial service.
7. Pit manufacturer shall provide removable ladders for attachment to access cover assemblies where ladders are indicated on plans. Manufacturer provided ladders shall extend from at or above grade to vault floor and be equipped with handrails extending above grade when cover is opened.
8. Identification shall be provided in raised letters on access covers. Identification shall be “Fuel System Vault Access.”

PART 3 - EXECUTION

3.01 SETTING AND ALIGNING EQUIPMENT

A. Set and align all Equipment supplied under this Section in accordance with manufacturer's recommendations.

B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.

C. Provide coupling alignment records indicating parallel and angular dial indicator readings as well as coupling manufacturer's tolerances. Alignment for pumps, couplings, and drivers requiring "cold" and "hot" settings shall be checked in both conditions and so indicated on the alignment record.

D. Retighten all bolted and threaded connections after installation.

3.02 INSPECTIONS

A. The Work will be inspected by DEN at intervals appropriate to the stage of construction during the course of construction.

B. Provide for inspection by all others having jurisdiction over the work performed under the various Sections of these Specifications during the proper phase.

C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.03 ADJUSTMENTS AND CALIBRATION

A. Contractor shall adjust all valves for the flows, level settings, and pressure settings indicated and specified.

B. Set rate of closure of control valves to eliminate surges and shocks in the systems as installed.

C. Final adjustments shall be made during system operation prior to final start-up.

D. Adjust all items at start-up, including flow rates, pressure settings, meter settings, and other variables as required by DEN's representative on the job.

3.04 VALVE AND EQUIPMENT INSTALLATION

A. Install where indicated on the Drawings and in accordance with manufacturer's recommendations.

B. Replace any and all valves and Equipment that prove defective during testing.

C. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for DEN's operation.

D. Install all butterfly valves with the disc shaft in the horizontal axis.

E. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.

F. For adapters with integral screens: remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.05 PIT ASSEMBLIES

A. Although the pit assemblies have been specified as assemblies, certain components may be shipped loose. Contractor shall account for all loose components and assemble.

B. Contractor shall establish and coordinate with all parties the dimension required between the top connection point of the hydrant pit valve and the hydrant pit lid/cover.

3.06 CLEANING AND PROTECTION

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.

B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.07 EQUIPMENT TEST AND CHECKOUT

A. Before Equipment installations will be accepted, Contractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.

B. All testing and checkout procedures of the manufacturer shall be carried out completely.

C. All tested Equipment found to be defective or inoperable to any extent is to be reported to DEN immediately.

D. Any operating difficulty or defective item as a result of Contractor's work shall be repaired or replaced and put into proper operation by Contractor immediately.

E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Payment for “Remove and Replace Hydrant Pit to New Location (New Hydrant Pit Assembly)” shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for “Remove and Replace Hydrant Pit to New Location (New Hydrant Pit Assembly)” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 335245-1 Remove and Replace Hydrant Pit to New Location (New Hydrant Pit Assembly) – per each

END OF SECTION 335252

SECTION 335253

FUEL SYSTEM INSPECTION, TESTING, AND FLUSHING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the inspection, testing, and flushing of all fuel system piping, testing of corrosion protection coatings, and Equipment performance.

B. Provide for the "Gas Free" conditions required by Section 335245, as applicable to the Work of this Section.

C. Filling of new and modified fuel system piping with fuel shall not occur until within 30 days of the respective system portions being placed in service. Contractor shall be responsible for reflushing of new and modified fuel system piping where fuel has remained stagnant for 30 days or more, at no additional cost to DEN. Contractor shall nitrogen charge to 10 psi, new and modified fuel system piping which has been completed and will remain out of service longer than 60 days.

1.02 REFERENCES

A. Airlines for America (A4A):

1. ATA Spec 103 - Standards for Jet Fuel Quality Control at Airports.

B. American Petrolium Institute

1. API EI 1529

C. American Society for Testing and Materials (ASTM):

1. D1655 - Specification for Aviation Turbine Fuels.
2. D2276 - Test Methods for Particulate Contaminants in Aviation Turbine Fuels.
3. D4176 - Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels.

D. National Fire Protection Association

1. NFPA 407
2. NFPA 415

E. American Society of Mechanical Engineers (ASME):

1. B31.3 - Process Piping.

1.03 SUBMITTALS

A. Submit detailed procedures for testing methods for approval before proceeding with pipe fabrication. This includes all radiographing and other pipe welding NDE, pressure testing, holiday testing, and flushing.

Submit detailed flushing procedures, including a spill prevention and safety plan, for approval 30 days prior to scheduled completion of pipe fabrication. Flushing procedures shall not commence prior to approval. Contractor will be responsible for obtaining a fuel

flushing permit from the Denver Fire Department (DFD).

B. Submit examination personnel qualifications before proceeding with any testing method.

C. Submit completed examination procedures with actual testing data (readings) and signatures of examination personnel.

1.04 QUALITY ASSURANCE

A. All tests (radiographing and other pipe welding NDE, pressure testing, holiday testing, and flushing) shall be performed in accordance with ASME B31.3.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.01 GENERAL

A. Compressors used for air testing shall have sufficient capacity to bring the system under test up to the test pressure in a maximum of 20 minutes. As an alternate, industrial dry nitrogen can be utilized provided the Contractor submits and obtains approval of a safety plan for working with nitrogen in the excavations, vaults, pits and otherwise confined spaces.

B. DEN will furnish all aviation kerosene fuel for testing and flushing the interior of new and modified fuel carrier piping except as otherwise specified.

C. Contractor shall provide and operate all temporary equipment required for fuel system inspection, testing and flushing including tankers, fuel transport trucks, gauges, instruments, hoses, connections, temporary pumps, temporary filter separators, electronic holiday detectors and other items specified or required.

D. Contractor shall provide all required labor associated with fuel system inspection, testing and flushing.

E. Contractor shall not reuse bolts, studs, nuts, or gaskets removed during installation and testing. Furnish all bolts, studs, nuts, and gaskets for makeup of all connections to the Equipment and replace all gaskets damaged during storage, inspection, cleaning, or placing into service.

F. Procedures:

1. Test pipe welds per section 335245.
2. Perform holiday testing of coating systems on all piping including joints.
3. Pneumatically test fuel carrier piping.
4. Hydrostatically test fuel carrier piping.
5. Flush fuel carrier main piping per the requirement of Section 335253.13.
6. Upon flushing the main piping, flush 6” lateral piping.
7. Install hydrant valves.
8. Electrically test all insulating flanges and joints.

9. Water shall not be used for testing fuel piping.

10. Perform preliminary pneumatic tests and final hydrostatic fuel tests before piping joints are concealed with backfill or other construction. Variances from this may be allowed but must be approved by DEN and Engineer.

G. Responsibility of Contractor:

1. Notify the proper authorities and DEN that items are ready for inspection and testing. Twenty-four hours' notice shall be given for all inspection and tests.

2. Furnish and install all necessary equipment, materials, and personnel including pumps, compressors, gauges, and valves. Valves shall be approved by DEN and shall be suitable to hold test pressure for the specified time without leakage.

3. Conduct the tests of all systems in a safe manner and correct all deficiencies.

4. Apply the specified test pressures by means of a pump or compressor connected to the piping of highest elevation and plug tightly afterwards.

5. Be fully responsible for operating trucks and equipment throughout the testing and flushing operations.

6. Obtain and pay for all necessary approvals, acceptances, and permits.

7. Contractor shall make provisions to conduct all tests during inclement weather, if necessary.

8. Submit test results to DEN Project Management and/or the Denver Fire Department (DFD) for review within 48-hours of the completion of any test. DFD Informal Acceptance will be required before proceeding to the next test procedure.

3.02 FUEL CARRIER PIPING PNEUMATIC PRESSURE TEST

A. A pneumatic test shall be applied in accordance with ASME B31.3 NFPA 407 and as approved by the Denver Fire Department (DFD) to the entire length of buried fuel pipe installed under this Contract.

B. All pneumatic testing shall be done using dry compressed air at -20^{o}F dew point. As an alternate, industrial dry nitrogen can be utilized provided the Contractor submits and obtains approval of a safety plan for working with nitrogen in the excavations, vaults, pits and otherwise confined spaces.

C. Install temporary closures or other fittings, including Victaulic coupling caps, blind flanges, and similar items, as necessary for the integrity of the piping system to be tested. Permanent valves and adapters shall be in place for testing.

D. Backfill to include flowable fill,between joints before application of test pressure.

E. The pressure shall be gradually increased until a gauge pressure which is one-half the test pressure, 5 psig, is attained, at which time a preliminary check shall be made, including examination of exposed joints in accordance with ASME B31.3. Thereafter, the pressure shall be gradually increased in steps until the test pressure of 25 psig is reached, holding the pressure at each step long enough to equalize piping strains.

F. Maintain 25 psig pressure for at least 4 hours.

G. Soap exposed joints and carefully inspect to detect leaks.

H. Pressure and temperature reading shall be taken as follows:

1. Temperatures shall be representative of actual conditions.

2. Readings shall not be taken during times of rapid atmospheric changes.

3. There shall be no indication of reduction in test pressure after corrections for temperature and pressure have been made according to the relationship $T_1 P_2 = T_2 P_1$, where T and P are absolute temperatures and pressures and subscripts refer to initial and final readings.

4. Provide calibrated temperature and pressure instruments and chart recorders to provide continuous temperature and pressure readings variations during the tests. Instruments shall be calibrated for temperature and pressure immediately prior to each test. Recorder charts shall be signed by a DEN representative at the completion of testing and submitted to DEN for review prior to final acceptance of the piping.

I. Repair defective joints and repeat tests until approved.

J. The results of pressure test are to be submitted to DEN for review and approval within 48-hours of completion of the test, and then to the Denver Fire Department (DFD) for review and informal acceptance.

3.03 FUEL PIPING HYDROSTATIC PRESSURE TEST

A. Apply a liquid pressure test with a grade of aviation kerosene fuel approved by DEN to the entire system following the pneumatic pressure test.

B. The pressure shall be gradually increased until a gauge pressure of not more than 50 psig, is attained and held for 10 minutes, at which time a preliminary check shall be made, including examination of exposed joints in accordance with ASME B31.3, NFPA 407 and as approved by the Denver Fire Department (DFD). Thereafter, the pressure shall be gradually increased in 25-psig steps with a 10-minute hold after each step until the test pressure of 265-psig is achieved, holding the pressure at each step long enough to equalize piping strains..

C. The test pressure of 265 -psig shall be maintained for a 4-hour period while continuously recording temperature and pressure. The pressure is then to be gradually reduced to less than 50-psig, and the test is to be repeated with a second 4-hour hold at the final test pressure while continuously recording temperature and pressure.

D. Submit plan and procedure for repair of any identified leaks to DEN prior to commencing any repair work. Repair any leaks in a manner approved by DEN. Following completion of the repair, repeat the entire pneumatic and hydraulic pressure testing process.

E. Provide calibrated temperature and pressure instruments and chart recorders to provide continuous temperature and pressure readings variations during the tests. Instruments shall be calibrated for temperature and pressure immediately prior to each test. Recorder charts shall be submitted to DEN for review prior to final acceptance of the piping.

F. Permanent valves and adapters which are rated for the test pressure shall be in place for the liquid pressure test. Equipment which is not rated by the manufacturer for the test pressure shall be removed prior to testing. Install temporary connections as necessary.

G. For final tie-in welds, NDE of the welds and in-process welding examination in accordance

with ASME B31.3 and Section 335245 and careful observation of the system piping put under operating pressure with fuel before joints are covered will satisfy the requirement for this testing. This includes points of system interconnection.

H. The results of pressure test are to be submitted to DEN for review within 48-hours of completion of the test, and then to the Denver Fire Department (DFD) for review and informal acceptance.

3.04 INSPECTION OF COATINGS:

A. Contractor shall make a detailed inspection with a holiday tester of all pipe coating and joint coating preceding the lowering of the pipe.

B. Contractor shall make a detailed inspection with a holiday tester of all coating repairs to include welds and any other attachments per SECTION 33 52 46.

C. Holiday-tester voltage shall not be higher than the manufacturer's recommended voltage for the coating tested. Testing shall be for holidays only and not to test the dielectric strength of the coating materials.

D. All holidays and damaged or broken places in the coating shall be repaired in a workmanlike manner at Contractor's expense.

E. All holidays shall be patched using the methods specified for field-applied external protective pipe coating and procedure in Section 335246. and re-tested until successfully passing the holiday tests.

F. Holiday Test Reports are to be submitted to DEN for review within 48-hours of completion of the test, and then to the Denver Fire Department (DFD) for review and informal acceptance prior to concealment of fuel piping and fittings.

3.05 TESTING OF INSULATED FLANGES AND JOINTS

A. Each insulating flange and joint assembly shall be tested with an approved ohmmeter.

B. Ohmmeter used shall have at least 20 megohms, full-scale deflection when using the meter's highest dc resistance multiplier setting.

C. Ohmmeter tests shall be made when flange assembly is dry using the highest multiplier setting and shall indicate infinity measured between each stud and both flanges.

D. Each insulating flange assembly shall be field tested after installation and shall be tested not higher than the manufacturer's recommended voltage.

E. Insulating flanges in the existing hydrant pits shall be tested by this Contract after installation of hydrant pit valves provided by this Contract.

3.06 FUEL HANDLING

A. Contractor shall prepare documents inventorying the fuel removed from the system for drain downs, flushing, etc. The documents shall record the volume of fuel contained in the tanker trucks and temporary portable storage tanks provided by Contractor and removed from the fueling system to complete the Work. The tanker trucks and temporary portable storage tanks shall be made available to DEN for witnessing the inventorying of the same. DEN will

inventory Contractor-furnished vacuum trucks-It will be the contractor's responsibility to dewater hydrant pits and fuel vaults that require access under this scope of work. Fuel shall not be removed from airport property without DEN signed documents recording the fuel being removed from airport property.

B. Contractor shall not waste, spill, or contaminate the fuel used for testing, filling the system piping, completing tie-ins, drain-downs, flushing, and other Work requiring fuel to be removed from the fueling system or handled. The cost of all fuel spilled, wasted, or contaminated by Contractor shall be paid for by Contractor to DEN at the purchase price (spot market price) times a 1.15 multiplier.

C. Fuel shall remain or become the property of DEN upon completion of testing, flushing, etc., after the fuel quality has been tested and confirmed by a third-party laboratory employed by the Contractor at no additional cost. Third-party laboratory shall be subject to approval by DEN and the fuel system operator.

D. Contractor shall transport acceptable fuel and offload the fuel back into the operating storage tanks at the airport fuel storage facility. Fuel that is unacceptable (fuel quality acceptance determination by third-party laboratory) shall be removed from the Site and disposed of at Contractor's expense along with reimbursing DEN for fuel as noted above (1.15 times spot market price).

E. Contractor shall use certified clean, detergent free (steam cleaned) temporary portable tanks, tanker trucks, etc. for storing and transporting fuel removed from the system. These shall be steam cleaned first with a minimum sitting time of 15 minutes and a tank temperature above 245 degrees F, followed by a hot water rinse and hot air dry. Interior coatings of temporary portable tanks, tanker trucks, etc. used shall be compatible with Jet A fuel. Trucks/tanks shall be completely drained and water/product free upon arrival at site, prior to use. Contractor shall provide documentation from tank cleaning company describing procedures used, verifying that no detergents were used and that trucks/tanks are product and water free. Contractor shall coordinate with Fuel System Operator for operator inspection and approval of tanks or transport tanks 24 hours prior to staging for flushing operations. Contractor shall provide written sign-off documentation to DEN, accepted and signed by both Contractor and fuel system operator, confirming that acceptable truck/tank cleanliness conditions exist prior to staging and commencing flushing operations.

F. Additional cleaning of tanks/tankers due to a failed inspection shall be done at the contractor's expense.

3.07 FLUSHING

A. Before a new, modified, or repaired hydrant fuel system, or portion thereof, is placed into service, all piping affected by change shall be flushed to ensure system cleanliness before aircraft fueling is permitted.

B. All flushing procedures, fuel sampling and testing shall be in accordance with ATA 103, latest revision.

C. The installing Contractor shall be responsible for all flushing requirements.

D. A reasonable amount of fuel required for flushing and testing will be supplied by DEN through the airport hydrant system. Contractor shall make arrangements with and coordinate with the DEN Fuel System Operator for operation of the fuel system pumps for the flushing operations. Product used for flushing shall meet ASTM D1655, latest revision,

specifications for kerosene Jet A/A-1 type aviation grade turbine fuels.

E. Desired flow rate of flush is 10 feet per second minimum unless a lesser rate is agreed upon by all airline quality assurance representatives of the affected airline(s) and documentation is provided of such approval. Three volumetric changes of the piping affected are required at velocity before proceeding with the first test samples are taken.

F. No flushing will be allowed through control valves, meters or hydrant pit valves.

G. Test samples shall be drawn immediately ahead of transport trucks or frac tanks on dead end flushing systems. A minimum of two consecutive acceptable test results is required to ensure piping cleanliness.

H. Contractor shall supply any temporary manifolds plus a sufficient number of tank trucks and hoses to allow the desired flow rates and necessary volumetric change through the hydrant laterals to be achieved in a safe manner.

I. Unless otherwise noted in the specific flushing procedures herein, hoses and couplings shall be aircraft type with a minimum 300 psig rating and shall be constructed and hydrostatically tested per API/EI 1529. Four-inch (4-inch) hose size (multiple manifolded hoses if required) shall be used to achieve flow capacities during flush without exceeding a maximum allowable flow rate of 600 gpm through a single 4” hose. Hoses, couplings and temporary piping shall be adequately supported and restrained to mitigate the potential for movement, leakage or failure during flushing operations. Velocities in excess of 17 feet per second on any portion of fuel piping is not allowed.

J. Contractor shall provide a clamp-on type ultrasonic time-of travel flow meter or other type of direct reading flow meter to the flushing connection to ensure the correct flushing velocity is attained, velocity is to be tested and confirmed by a third-party laboratory employed by the Contractor at no additional cost. Instruments shall be calibrated for velocity prior to flushing. Test reports shall be submitted to DEN for review prior to final acceptance of the piping.

K. All general service valves and adapters shall be in place throughout the flushing procedure. Contractor shall remove control valves and metering assemblies prior to initiating flush.

L. Contractor shall provide all filtration media required for return of fuel to the airport fuel storage facility following the system flush. This includes intermediate filtration media changeouts if excessive media loading or disablement occurs during return of flushed fuel to the fuel storage facility. Upon completion of flush and return of flushed fuel to the airport fuel storage facility, Contractor shall again provide new filtration media if replacement is determined necessary by DEN due to filter element loading from the return of flushed fuel. Contractor shall reimburse DEN for fuel facility operator labor costs incurred during these filter media changeouts.

M. Dead End Flushing of Hydrant Laterals Into Tank Trucks:

1. The system pumps of the fueling system will be used for the flushing procedure and shall be operated at Contractor's expense.
2. The filtration system of the fueling system will be used for the flushing procedure.
3. Flushing shall be accomplished by flushing fuel from the DEN Fuel Storage Facility storage tank, through the pumping/filter system, down the main dead-end pipe run into Contractor-furnished fuel transport trucks.
4. After main pipe line is clean, each hydrant fueling lateral shall be flushed clean. Flushing flow rate for each lateral will be 900-gpm (10-ft/sec.).
5. Refueler vehicles with filter membrane taps may be used when available in lieu of the fabricated test tee required to feed vehicles.
6. Procedure:
7. Caution: All electrical and motorized equipment in area should be shut down in case of a mishap or fuel spill. For safety, all persons not involved in the flushing operation shall be kept a minimum of 100 feet away from tank trucks and hydrant pits used in the flushing operation.
    a. Tank truck internal valves should be safety wired in an open position.
    b. Dry break couplers shall be provided at the end of all truck feeder hoses.
    c. All quick-release type couplings shall be safety wired when coupled to the bottom load receptacle and hydrant adapter.
    d. Hoses shall be secured in a manner to prevent whipping during flush.
    e. Bond truck or tanks to hydrant system piping.
    f. Start product flow slowly before reaching flushing velocity to check for leaks and system tightness.
    g. Fire extinguishers shall be in place in case of emergency and a fire watch maintained by the Contractor. Fire watch shall be in accordance with Denver Fire Department (DFD) requirements.
    h. Location of test personnel:
        1) One person per each tank truck to monitor fuel level in tank.
        2) One person at each hydrant pit to control fuel flow into tank truck.
        3) One person at main pump control station to shut down pumps in emergency.
        4) One person at nearest terminal EFSO station to shut down pumps in emergency.
        5) One person manning fire extinguisher(s) – Fire Watch.
        6) One person removed from manual tasks in command of flushing operation.

N. Contractor shall provide aboveground "test tee" for membrane test to be performed after flushing.

O. After main pipeline is clean, each hydrant fueling lateral shall be flushed clean.

P. Acceptance Specifications:

1. Visual - All fuel samples shall be clear and bright. Other visual clues must be observed and acted upon accordingly, i.e.; feel, color, odor, and similar characteristics. This test shall be performed in accordance with ASTM D4176.

2. Perform a membrane test per ASTM D2276. A minimum of 1 gallon of jet fuel shall be used for this test. Visually assess the membrane and compare it with a color rating booklet. The color shall be a maximum of #3 Rated Wet with a particulate contamination not exceeding the B scale. Flushing shall continue, and the membrane test repeated, until a sample is obtained which meets these requirements.

3. Note: If color rating exceeds the above limits or is in dispute, a matched weight gravimetric rating not to exceed 0.5 mg/gal shall govern. (the Contractor shall be responsible for all coordination relating to the execution of this testing method)

4. Water - 5 ppm maximum.

5. Water Separation (Microsep) Rating - 85 minimum.

Q. Final Acceptance: It shall be the responsibility of the airline fuel quality assurance representative, or his designee, to have final decision on system cleanliness and acceptance before aircraft fuel servicing is permitted. Test results are to be submitted to DEN and the QA representative(s) of the affected airline(s) for acceptance before the system can be returned to service.

R. Contractor shall pump, drain, or vacuum all fuel out of the hydrants, vaults, equipment, piping and fuel hoses on the site. Fuel meeting the acceptance criteria listed in the preceding paragraphs shall be returned to the DEN fuel facility. Fuel not meeting the DEN acceptance criteria shall be properly disposed of offsite.

S. After flushing has been completed and approved, Contractor shall remove all temporary cross connections and related items, and install control valves, metering elements, strainer baskets, and other system components. The contractor is responsible for operationally testing and ensuring proper operation of all equipment impacted by this work. The contractor is responsible for returning the fuel system in fully functional order.

T. The Contractor shall submit a compete flushing report to DEN for review within 24-hours of completion of the flush, to be reviewed and approved by the Engineer, then to the Denver Fire Department (DFD) for review.

3.08 PERFORMANCE TESTING

A. Contractor shall subject the entire fueling system to such operating tests as required by DEN, to demonstrate satisfactory functioning and operating efficiency.

B. Tests shall include checks to determine that all control valves and switches are properly adjusted.

C. Testing shall include the functions of the complete electrical system.

D. All instruments required to conduct the tests shall be furnished by Contractor.

E. All tests may be witnessed by a representative of DEN.

F. Submit typed samples of test reports to DEN for approval.

G. Submit completed test reports.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. Payment for “Fuel Pipe Testing and Flushing” shall be measured via witnessed and verified tests and reports submitted per lump sum.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for fuel line testing and flushing necessary to comply with this specification will be made at the contract unit price per lump sum for work installed in-place, completed, and approved by the DEN. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 335253-1 – Testing and Dead-End Flushing of the Hydrant Laterals into Tank Trucks – per lump sum

END OF SECTION 335253

EXHIBIT J

CONTRACT DRAWINGS

202474451: MILLSTONE WEBER LLC

GARDI A Southeast

Incorporated by Reference as found in File #20240101
at the Denver Office of the Clerk and Recorder

EXHIBIT K

INVITATION FOR BID

202474451: MILLSTONE WEBER LLC

GARDI A Southeast

Incorporated by Reference as found in File #20240102
at the Denver Office of the Clerk and Recorder